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ALVIN J. COX, M. A., PH. D.
GENERAL EDITOR

SECTION D
GENERAL BIOLOGY, ETHNOLOGY, AND ANTHROPOLOGY

EDITED WITH THE COÖPERATION OF

M. L. MILLER, PH. D.; R. P. COWLES, PH. D.; C. S. BANKS, M. S.
ALVIN SEALE, A. B.; C. F. BAKER, A. M.
RICHARD C. McGREGOR, A. B.

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VOL. IX FEBRUARY, 1914 No. 1

PRESERVATION OF COMMERCIAL FISH AND FISHERY PRODUCTS IN THE TROPICS

By ALVIN SEALE

(From the Section of Ichthyology, Biological Laboratory, Bureau of Science, Manila, P. I.)

Two plates

PRESERVING BY DRYING AND SALTING

Almost every country has its own methods for drying and salting fish due to local conditions.

In the provinces of the Philippine Islands almost all of the fish for home consumption are simply sundried with but a sprinkling of salt or without salt. This economy of salt is probably due to the difficulty of securing it and to the fact that the fish are not to be kept for a great length of time. However, in some places, like Sitanki Island, where the salting of fish is the most important industry and the work is chiefly in the hands of Chinese, the following method is employed: The fish are caught by the Moro fishermen who clean them promptly, usually while still on the fishing ground. The fish is placed in front of the operator with the belly uppermost and the head inward; a cut is made along the side of the backbone from the base of the tail to near the head. The fish is then turned over, and a similar cut is made on the other side of the backbone to the tip of the snout, the skin on the belly alone remaining intact. The fish is then opened by cutting the upper or head end of the

backbone and the posterior end of the body cavity. This enables the operator to spread the fish out flat in three united sections, the backbone constituting one section. If the fish is very large, two gashes are cut in the thickest part of the flesh on each side so that the salt may penetrate more quickly. The entrails are then removed. The entire operation requires less than half a minute by an experienced Moro using a bolo. The fish are then sold to Chinese, who place them at once in a large vat of brine sufficiently strong to float a potato. About 1 sack of salt to 3 picules of fish (418.5 pounds) is used, but this brine is too weak. The fish are usually left in these vats for three or four days; then they are placed on platforms to dry; each evening, or when rain threatens, they are gathered up and piled in kenches. This process is continued until they are thoroughly dry and ready for the market. Dried fish from Sitanki are said to spoil very readily. I believe this to be chiefly due to the lack of care in keeping the brine sufficiently strong and the vat sanitary.

In Manila, where a very large quantity of small fish is cured, especially sardines and young herring, the process is as follows: The fish are washed in sea water when they are removed from the boat, placed in strong brine for from two to three hours, and spread on flakes until thoroughly sundried (Plate I). They are then ready for packing and shipping. These fish are dried in the round, and are covered each night and during showers. Owing to the fact that frequently fish of from 20 to 22 centimeters were included in the lot, they were not cured properly. Consequently, a city ordinance was passed requiring the evisceration of fish of more than 15 centimeters in length, when they were to be sundried. This was purely a sanitary measure.

During the dry months in the Philippines, it is much better to depend upon sundrying with a minimum amount of salting for preserving fish. On the Grand Banks of the Newfoundland coast, the fish are stored in kenches on shipboard. About 11.4 hectoliters (1.5 bushels) of salt for 45.30 kilograms (100 pounds) of fish are used for these. When the fishermen reach the shore, however, they cure the fish by pickling or by a combination of drying and pickling.

PICKLING

In pickling fish it is customary to use either a rectangular trough or a large hogshead which will hold about 193.05 liters (51 gallons). This is called a butt. A thick layer of salt is sprinkled on the bottom of the butt, then the fish are placed in

the butts in layers, the split surface up. Salt is sprinkled over each layer so that all parts of the fish are well covered, and a half bushel of salt is placed on top to make a strong pickle. The amount of salt required for each hogshead is from 1.4 to 2.5 hectoliters (4 to 6 bushels). When the fish settle, they are covered with strong brine, and in this condition they will keep until needed.

When the fish are taken from the butts, they are carefully stacked in piles from 0.9 to 1.2 meters (3 to 4 feet) high called kenches. This is to allow the brine to drain off. With the exception of the lower layer, they are stacked with the cut side down. At the end of from twenty-four to forty-eight hours they are put out to dry on bamboo racks about a meter from the ground, being spread cut side up. After one day of drying they are repiled or kenched for from twenty-four to forty-eight hours and then dried again for two days or until perfectly dry. I strongly advise that they then be packed in large cooking bags or oilpaper, made up into neat packages, and stored in a dry place. Fish prepared in this manner will keep in good condition in the Philippines for months.

Regarding the quantity of salt used in curing iced or fresh fish in the United States, A. W. Bitting writes: [1]

> About half a pound of salt is used to the pound of iced fish in the regular course of curing the full salted fish; for export fish about three-eighths of a pound is used, and for slack salted one-fourth of a pound. As the cured fish contains only from 14 to 20 per cent of salt, it is evident that about 33 per cent of the amount used serves as a preservative while the remainder acts as a drying agent, and it would seem that improved methods might effect a marked saving in this part of the process, * * * sufficient drying and retention of that dryness under varying weather conditions will assist in preventing spoilage.

It is in this connection that we urge the use of oilpaper or large cooking bags for packing fish, as this tends to prevent the entrance of dampness which would cause the fish to mold—and this is the greatest difficulty we have to contend with in preserving dried fish in the Philippines.

SALTED SHRIMPS OR PRAWNS

At certain times of the year very young prawns from 2 to 3 centimeters in length are sold in the Manila markets. These are preserved by being mixed with a liberal quantity of coarse salt and then placed in kerosene tins. They find a ready sale.

[1] *Bull. U. S. Dept. Agr., Bur. Chem.* (1911), 133, 27, 29.

SALTED CRABS

During the rainy season, great quantities of small crabs are caught in the brackish waters of the esteros near Manila. They are usually lightly sprinkled with salt and offered for sale the next morning in the Manila markets. This crab, *Varuna litterata* (Fabr.), is apparently not taken in large numbers at any other season.

MULLET ROES

There are at least 16 species of mullets or *banak* found in Philippine waters. They are good food fishes and usually abundant in all parts of the Islands. Several thousands have been caught at one haul of a big seine. The roes of these fish are a great delicacy, but I am not aware that they are conserved in any manner in the Philippines. The following is an abstract of one method [2] for preparing mullet roes:

> The fish are split open and the roes removed, care being taken to avoid breaking the roe bags or bruising the eggs. They should be separated carefully from the surrounding viscera. The roes are placed in tubs with holes in the bottom so that the water can run off. The roes, still in the roe bags, are then placed in boxes or kegs with fine salt sprinkled over and between them. An excess of salt must be avoided as it will cause the egg sacs to break. About 1 peck of Liverpool, or any fine, salt should be used to 160 pounds of eggs.
>
> On removal from the salt, the roes are spread on boards and exposed to the sun for about one week, being covered at night. They are turned over each morning and protected from rain. Sometimes, after one day's exposure, other boards are laid on top of the roes to compress them slightly. When properly cured they are from 4 to 8 inches long, from 2 to 4 inches wide, and from one-half to two-thirds of an inch thick. They vary in color from yellowish to dark red. These are now ready to be packed in small boxes and marketed.

In Italy the hard roes of mullet are converted into cakes termed *bolarge* or *bolargo*, which are prepared by washing and sprinkling with salt and pressing between two boards. They are then smoked or sundried, and are a good appetizer in that they promote thirst. In India these roes are considered excellent for curries.

BAGOONG

Bagoong is the most common fish preparation in the Philippines. In almost every native home it is more or less of a staple. It is prepared by mixing 2 parts of young or small fish—anchovies

[2] *Bull. U. S. Fish Comm.* (1898), **18**, 546.

preferred—with 3 parts of salt. This is placed in stone jars, covered to exclude flies and dirt, and allowed to ferment for one month. It is then ready for use, the liquid portion being used as a sauce and the solid fried or mixed with rice. Care should be taken to prevent flies from depositing their eggs in this mixture as otherwise it becomes filled with larvæ and is most unappetizing. However, it is sometimes eaten in this condition.

PRESERVING BY SMOKING

In its simplest form, the preservation of fish by smoking is as follows: The fish are first dressed. If large, they are split down the belly from head to tail so that they lie flat. The head and most of the backbone are removed. Usually the flesh is gashed in several places to allow the salt to penetrate. The fish are next placed in vats or barrels with 22.66 kilograms (50 pounds) of No. 2 salt and from 2.27 to 4.54 kilograms (5 to 10 pounds) of granulated sugar to 91 kilograms (200 pounds) of fish. On the second day, brine made by dissolving 13.61 kilograms (30 pounds) of salt in 18.9 liters (5 gallons) of water is added. After the fifth or sixth day, the fish are removed and soaked in fresh water for three hours. They are trussed out flat, hung on sticks or bamboos, and permitted to dry for from two to three hours in the open air. They are then hung in the upper part of the smokehouse away from the heat, but not so high as to be in the hot air which accumulates at the top. The smoking is continued for from eighteen to thirty-six hours, twenty-four of which are usually required to complete the process. When low smokehouses are used, in which the fish are hung within from 2.5 to 3 meters (8 to 10 feet) of the fire, the smoking is usually completed in less time than this. The smoke must be even throughout and with little fire. When sufficiently smoked, the fish are permitted to cool and are then packed with paper wrapped about them. The price in the United States for fish prepared in this way is usually from 36 to 40 centavos per pound.

The smokehouse may be of almost any shape or size, from an inverted barrel to the elaborate brick house with outside furnaces. A common form is one with three or four chambers, ranged side by side, from 1.83 to 4.27 meters (6 to 14 feet) high, 1.22 to 1.52 meters (4 to 5 feet) wide, and 1.83 to 3.66 meters (6 to 12 feet) deep. Hardwood or hardwood sawdust is used for producing the smoke.

Variations from the above method are innumerable, and depend largely upon the variety of smoked product to be prepared, and the size and variety of the fish to be smoked must be taken into consideration.

For the smoking of small fish such as young herring or sardines, the Chinese of Manila have very extensive smokehouses and drying yards, and a large business is carried on by them. This business has increased wonderfully within the past six years. In 1909 there were but 14 houses and yards for drying and smoking fish; in 1911 I counted 36 such establishments all owned by Chinese, who were preparing the fish, not only for local consumption, but for export to China as well. In 1912 almost all of these establishments were destroyed in the great Tondo fire, but at this date (1913) many have resumed operations.

The method of their operation, which is effective and economical although rather crude, is as follows: The fish—usually herring or sardines—are landed at Tondo beach (Plate I). They are dipped in salt water and washed, but not eviscerated. They are then put in strong brine for from two to three hours (very small or young fish for less time) and then dipped in boiling water for a few moments (Plate II). For the latter purpose, large kettles over a crude earthen furnace are used. The fish are then drained and spread in the sun for about one hour to dry (Plate I). They are next placed in round baskets about 40 centimeters in diameter, 100 fish to the basket (Plate II). These baskets are placed over one of the openings in the furnace to smoke. The furnace (Plate II) is usually constructed of stone or cement, and is about 1 meter high and 1 meter wide, while the length usually is limited only by the length of the house. There may be two or more rows of these furnaces in each house. The furnaces are supplied with holes in the top about 50 centimeters apart for the smoke to pass out; otherwise they are entirely closed. A smoke of hardwood sawdust is started, and the basket of fish is placed over one of the holes of which there are from 5 to 40 in each furnace. Usually several baskets are placed one above another, and over the top basket is always placed a tightly woven basket cover (Plate II). After smoking for ten hours the lowest basket in shifted to the top and the smoking is continued until the fish are properly cured. The length of time necessary for this process depends largely upon the size of the fish. The fish intended for sale in the local markets are usually smoked for twenty-four hours. Small

fish require less smoking, export fish more. These baskets retail for 60 centavos each.

If the fish are placed at a distance from the fire so that the temperature is never above 26°.7 C., the product is called "cold smoked," but if the fish are hung very near the fire and are more or less cooked it is called "hot smoked." The latter method requires only about two hours, but the product will keep but a very short time.

The "cold smoked" is the better product. The smoking may last from a few hours to two or three weeks, depending upon the product desired. Hardwood or hardwood sawdust makes the best smoke, but I have succeeded in making a very good product by using half-dry and green coconut husks.

I have conducted a number of experiments in smoking fish, using the following, all of which are very common in the Philippines: Barracuda, sea bass, mullets, cavalla, snappers, and porgies. The fish were thoroughly cleaned and washed, and the backbones removed. Some of the larger ones were cut in strips. They were put in strong brine for one day, allowed to drain and dry two days in the sun and wind, and then transferred to the smokehouse and smoked slowly for fourteen days, after which they were placed in the sun for half a day. Finally, they were wrapped in oilpaper and were sealed in tin boxes. After nine months in Manila, these fish were eaten and pronounced excellent.

A very appetizing fish product was made by cutting the flesh of large fish in rather small strips, which were placed in brine for one hour and transferred to spiced vinegar for three days, then sundried and slow smoked nine days. When wrapped in oilpaper and packed in tin boxes, these kept in good condition in Manila for four months. The following is an abstract of a method which the United States Bureau of Fisheries [3] recommends for preparing a choice fish product for warm climates:

> The fish, after being smoked, are cooled and placed in layers in wooden barrels. Between each layer of fish a layer of dry salt is placed in the proportion of about 6 pounds of salt to 100 pounds of fish. The barrels, after being filled, are kept in a cool place until the fish have become completely hard, which will require from three to fifteen days, depending upon the kind and size of the fish. The barrels are then filled with brine and closed by a tight-fitting cover. The brine must be carefully prepared in the following manner: Filtered water is boiled with salt to a saturated solution, cooled, skimmed, and as much drawn off as appears fully clear and fine. If the brine is not carefully prepared, the fish will not keep for

[3] *Bull. U. S. Fish. Comm.* (1898), 18, 477.

any length of time, which will likewise be the case if the process of hardening has not completely taken place.

Fish prepared in this manner will keep for many months and can be sent to hot climates without danger of spoiling.

SMOKED HERRING

The ordinary hard-smoked herring is prepared by pickling it in a tank of about 842 liters' (225 gallons') capacity. This tank is first partially filled with weak pickle made by adding 0.53 hectoliter (1.5 bushels) of salt to 100 gallons of water. From about 379 to 568 liters (100 to 150 gallons) of fish are then placed in the pickle, after which half a bushel of salt is put over them, and a third more of the fish is added. A second layer of salt, about 0.53 hectoliter (1.5 bushels), is laid on, and enough fish are then added to fill the tank which is finally covered with from 1.06 to 1.8 hectoliters (3 to 5 bushels) of salt. Each tank when filled contains 4 hogsheads of fish and from 2.11 to 3.17 hectoliters (3 to 5 bushels) of salt, the quantity of salt depending upon the size of the fish and the condition of the weather.

When the salt has struck, the time for which will require from twelve to forty-eight hours depending upon the size of the fish, the fish are dipped out and strung on sticks. They are then dipped in a trough of clean salt water and allowed to drain and dry for about one hour, after which they are hung in the smokehouse and the fires are started. The fish are smoked from three to five weeks. The sticks should be shifted so that a regular smoking is insured. It is best to fill the smokehouse gradually.

BLOATERS

The following is an abstract[4] of the method of preparing the popular fish product known as bloater.

Fresh herring are used and are pickled as soon as received, 1 bushel of salt being used to 1 barrel of fish. After remaining in the pickle for from two to three days they are removed, drained, and placed on sticks for smoking. In order to "bloat," the herring must be thoroughly moist. After they have commenced to dry in the smokehouse, the heat must be increased. If they hang for from ten to twelve hours without heat, they will not "bloat." The smoking continues for from two and one-half to six days, when the fish are usually sufficiently cured. Bloaters will keep but a short time, unless put in cold storage.

KIPPERED HERRING

To kipper herring, the fish are cleaned and salted like the bloaters, except that they are not kept in pickle so long. They

[4] *Bull. U. S. Fish Comm.* (1898), 18, 485.

are then hung up to dry for a few hours and smoked for from six to eight hours at temperatures of from 26°.7 to 29°.4 C., the fish being hung in such a way as to keep the abdomen open. They are then ready for cooling and packing.

"Kippered herring differ from bloater herring principally in that they are split and eviscerated before smoking." These will not keep well in the Philippines unless put in cold storage.

SMOKED CAT FISH

Cat fish may be smoked in the same manner as herring. However, if they are very large, they should first be cut into strips.

SMOKED EELS

The following is an abstract of a method used in Germany for smoking eels, from the United States Bureau of Fisheries:[5]

> The head, skin, tail, and viscera are removed, and the eel is split open the entire length, the backbone and many of the smaller bones attached to it are removed. It is then laid in strong salt brine for six hours and is then wiped dry with a towel and covered with the following preparation which has been pounded in a porcelain mortar: One large anchovy, 1 ounce fine salt, 8 ounces of sugar, 1 ounce saltpeter, and sufficient butter to make a paste of the ingredients. The eel, thoroughly cured with this preparation, is rolled up tightly in the form of a disk, beginning at the tail end, tied with a cord to hold it in position, and then sewed up in a linen cloth, which covers the disk and allows the end to project. These disks are next suspended in an ordinary smokehouse and smoked for from five to six days, then allowed to cool and become firm, when they are ready for the table.

MARINATING FISH

The method of conserving fish in spiced vinegar known in Europe as marinating has never been practiced to any extent in the Philippines. However, I believe that fish put up in this manner would meet with a favorable reception from consumers. For this purpose young herring, sardines, or anchovies are most desirable, although almost any small food fish may be used. Good firm fish, however, should be selected. The fish should be cleaned, washed, and dried for from half an hour to one hour in the air, then boiled or fried in hot oil (in Italy they are dipped in flour before frying), and put out to cool and to let the oil drain off. They are then packed in barrels, kegs, or glass jars, and spiced vinegar sufficient to fill the containers is poured in. After allowing them to stand a short time, the

[5] *Bull. U. S. Fish Comm.* (1898), **18**, 505.

bung is driven in or the cans sealed up. An excellent account of the method of marinating eels as practiced in Italy is given by James Hornell.[6]

CANNING SARDINES AND OTHER FISHES IN THE PHILIPPINES

I believe that there is a good opening for a moderate amount of capital in the canned fish industry in the Philippines. This is especially true if the fish cannery is operated in conjunction with some allied industry; for instance, a tomato-catsup factory. These two could easily be combined. Excellent tomatoes are grown in the vicinity of Manila, and a good market would stimulate additional planting. Oriental people prefer sardines put up in tomato sauce, so a portion of the output could be used for that purpose. The refuse of the fish cannery could readily be ground and pressed for chicken feed or fertilizer. Therefore, in a properly organized cannery there would be three products to put on the market—sardines, tomato catsup, and "bone meal" or fertilizer. Satisfactory labor at a reasonable rate could be readily secured. Taking into consideration the large quantities of fresh sardines landed each morning at Tondo beach, it is surprising that some local capitalist has not opened a cannery.

In brief outline, the method of preparing sardines is as follows:

Catch the fish.
Rinse the fish well in salt or fresh water.
Spread on tables or a clean floor and sprinkle with a little salt.
Clean by removing heads and entrails.
Place the fish in brine of sufficient strength to float a potato, where they should remain until the salt "strikes in." This will take from one-half to one hour.
Rinse rapidly in two waters to remove scales, dirt, and excess of salt.
Dry in the open air by placing the fish, tails up, in shallow wire baskets, so that water will run out of the abdominal cavity. In good weather one hour or even less is sufficient for drying. In bad weather, dry indoors. The wire baskets full of fish should be hung up so the air may circulate freely through them.
Cook the fish in oil by immersing these wire baskets with the fish in them in boiling peanut or olive oil. They should remain in the oil about two minutes or until the tail fin breaks easily.
Hang up the baskets so that the oil will drain off, and leave until the fish are cool.
Pack the fish in tins.
Fill the packed tins with olive oil, tomato catsup, or whatever is desired; a few cloves, small peppers, or thyme may be used.
Solder or clamp the covers so that they are absolutely air-tight.

[6] *Bull. Madras Fisheries Bureau* (1911), 2, No. 6, 50.

Immerse the cans of fish in boiling water for two hours. This cooks the fish and softens the bones.
Remove the cans from the water, allow them to cool, and rub them in dry sawdust to remove all oil from the outside.
The sardines are then ready for the market.

Using the above method, I prepared 100 tins of Philippine sardines to be used as an exhibit and afterward to be sent to various packing associations in order to interest them in the subject. The letters received in reply to these samples of sardines were in most cases very satisfactory. Owing to imperfect soldering, the oil leaked from some of the tins and the contents spoiled.

Dr. David Starr Jordan, president of Stanford University, wrote:

I had the can of the Philippine sardines you sent me served at the table. I consider them equal to the European sardines.

A member of the firm of Messrs. Castle Bros.-Wolf & Son, one of the largest commercial houses in Manila—now the Pacific Commercial Company—wrote:

I consider the quality of the sardines you sent us very good and see no reason why, eventually, the canning of these fish should not be an important industry.

According to the decision of the pure food experts of the United States Bureau of Agriculture, any small clupeoid fish may be put up in oil and labelled sardine, provided that the name of the country where the fish were caught and the kind of oil used in the tins are printed on the label.

This practically includes the entire family Clupeidæ. The following species of this family are found in Philippine waters, several of them in great abundance.

Species of clupeoid fishes found in Philippine waters.

Stolephorus gracilis (Temm. and Schleg.).
Stolephorus delicatulus (Bennett).
Amblygaster sirm (Rüppell).
Amblygaster clupeoides (Bleeker).
Amblygaster perforatum (Cantor).
Dussumieria acuta Cuv. and Val.
Dussumieria elopsoides Bleeker.
Dussumieria hasseltii Bleeker.
Sardinella moluccensis (Bleeker).
Sardinella gibbosa (Bleeker).
Sardinella sundaica (Bleeker).
Sardinella fimbrata (Cuv. and Val.).
Sardinella longiceps (Cuv. and Val.).
Sardinella vancibris (Jordan and Snyder).
Sardinella melanostica (Schleg.).
Sardinella klunzi (Bleeker).
Sardinella zunazi (Bleeker).
Ilisha hævenii (Bleeker).

There are in addition a large number of anchovies, family Engraulidæ, and a number of fishes of the mackerel family

found in the Philippines that could undoubtedly be canned with profit and sold on their merits.

However simple the process of canning sardines seems to be, I strongly advise against anyone entering the business without first securing the services of an experienced canning operator; otherwise failure would probably result.

In this connection, the following note is of special interest: [7]

> The sardine packers of France have of late, as a consequence of the very poor catch in the last few years, decided to close all their factories along the coast of Brittany and Vendée.
>
> This decision is partly due to the poor catch owing to the lack of fish and the antiquated fishing implements used by the Britton fisherman. It is noticed that in past years the fish which abounded along the coast of Brittany seem to have almost disappeared therefrom, or at least the sardine shoals are no longer to be found close to the shore as formerly and seem to be now in the offing. The fishermen being poorly equipped can not go too far off from the coast, and the consequence is that their catch is very trifling. They are unable to supply the factories with a sufficient quantity of fish, and when they secure a good catch try to sell it at very high prices. The manufacturers claim that the Spanish and Portuguese fish caught in large quantities are, on the contrary, sold at very low prices, and thus the Spanish and Portuguese manufacturers are enabled to favorably compete with French manufacturers.
>
> Over 100 factories were closed on January 1, 1913, and many others, it is said, will close before the end of January, 1914. It is also said that several manufacturers will reëstablish their works in Spain and Portugal. It is, however, hoped that their decision is not irrevocable, and that if the fishermen are enabled to improve their fishing implements the closed factories may perhaps be reopened before the next fishing season.
>
> The manufacturers' decision affects quite a number of industries, such as tin-can factories, olive-oil manufacturers, etc., and in Brittany alone over 50,000 people will thus be put out of employment. If the matter is not arranged between the canners and the fishermen, French sardines will be very scarce in the markets of the world.

PRESERVING FISH BY LOW TEMPERATURE OR REFRIGERATION

The preserving of fish and fish products in the tropics by means of cold is of sufficient importance to merit the most careful scientific observation. The subject is one of primary importance not only to the people of Manila, but also to the inhabitants of every city situated within the tropics and to all transoceanic vessels.

It has no doubt been the experience of almost every one who has traveled by sea that on some vessels all of the fish and frequently the meat and game from the cold storage were as dry as

[7] *Daily Consular & Trade Rep., Washington* (1913), 523.

chips and almost as tasteless, while on others they were all that could be desired.

I venture to state that this difference in the cold-storage foods was due almost entirely to a lack of understanding on the part of the engineer in charge of the refrigeration, a condition entirely inexcusable, considering the amount of information available and the numerous good books that have been published on the subject of cold storage. With the exception of salmon, halibut, and perhaps two or three other species, fish should never be frozen if it can possibly be avoided. A fish that has been fully frozen has a good appearance, and it is only when it is thawed out and cooked that its poor condition is revealed, the flesh being woolly in appearance, dry, and devoid of flavor. This is explained by the fact that fish flesh is largely made up of loosely bound, pale, muscular fibers which rupture very easily when frozen in contrast to the firmly bound red muscles of beef or mutton. Also, fish contain a much larger percentage of water than beef or mutton; therefore, freezing has a more disastrous effect.

Regarding the proper degree of cold at which fish should be kept, there is considerable difference of opinion among experts. The Director of the Insular Cold Storage plant recommends a temperature of —9°.4 C. for fish in Manila. The director of the Philippine Cold Stores states as a result of his experience that fish keep nicely in Manila at a temperature of from —6°.7 to —3°.9 C. This is also the opinion of the manager of the International Cold Stores. On the other hand, Mr. Heron, who has large cold stores and steam trawlers operating for the London trade, says:

> I am firmly of the opinion that if fish is required to be kept for a considerable period it must not be frozen, as the tissues cannot stand the freezing as in the case of beef and mutton.

He fully agrees with Anderson [8] who states in his recommendations to the Fishery Board of Scotland that—

> he found that from 0 degrees centigrade to —3 centigrade (32 degrees Fahrenheit to 25.6 degrees Fahrenheit) will prevent the action of most bacteria of putrification and at the same time maintain the fish in a condition of rigor, and thus preserve the fish for a considerable time in a comparative fresh condition, and with little deterioration in the tissue.

My own experience indicates that in Manila a round fish with the ordinary market handling, if placed in the refrigerative

[8] *Proc. Cold Storage & Ice Assoc. England* (1909), 9, 81.

room and kept at a temperature of from −0° to −3° C., will keep for from ten to fourteen days only. If the fish is carefully handled and gutted, the gills removed and the inside wiped with a dry cloth, and the fish wrapped in oilpaper, it will keep in sweet condition and retain its flavor for three weeks.

Herring and mackerel stand freezing better than most other Philippine fishes. Many people who have cold storage, especially Americans, believe the best way to preserve fish is to freeze them, then immerse in water, and refreeze or glaze. This method is extensively used in the Canadian and American fisheries.

There is also a method of freezing fish in ice while they are still alive, using oxygen to reduce the amount of water necessary to be frozen, but this method is still in the experimental stage. It is difficult to predict its future.

For ordinary transportation of fish from the fishing grounds to the market, it is usual for the vessel to carry a cargo of ice in the bins. This should be between decks in the coolest part of the ship and be as well insulated as possible. When the fish are caught, they are cleaned and washed at once. A layer of cracked ice from 7 to 10 centimeters thick is placed on the floor of one of the bins. A layer of fish is placed over this and covered with chiseled ice, grading into cracked ice to the size of a walnut. Alternating layers of fish and ice are put in until the bin is full, when a layer of ice 15 centimeters or more thick is placed over the top. If the room is kept at freezing point, these fish will remain from twelve to fourteen days or longer in sweet condition. If possible, and there need be no great difficulty if the fishing is along shore, the fish should be chilled before they are packed in the above manner, as they will keep longer and not require so much ice in shipping.

Great strides have been made in the shipping of iced fish in the past few years, and it is well demonstrated that careful handling and packing will amply repay the additional expense and trouble.

PREPARING FISH FOR SHIPMENT

A number of complaints have been received by the Bureau of Science that the dried fish put up in certain places in the Islands will not keep and that as a matter of fact quantities have to be thrown away because they are spoiled. This, undoubtedly, in the cases examined, resulted from slack salting and storage in damp bodegas. The only remedy for this is to spread the

fish in the sun for half a day and to keep the brine up to full strength. Shippers should see to it that the fish are absolutely dry—a simple matter in a country where the moisture evaporates as rapidly as it does in the Philippines.

Any firm that would take the slight additional trouble of putting up selected fish in smaller packages and wrapping these packages in oilpaper and then sacking them (instead of merely packing them in gunny sacks as is now the custom) would soon build up a most profitable trade.

With the exception of a few marketable fish brought from one or two southern ports, there are practically no fish shipped in fresh condition anywhere in the Philippine Islands. This is to be regretted and should be remedied as soon as possible, as there are a number of places in the Islands where large quantities of excellent food fish are caught which could easily be shipped to Manila. I believe there has been but one serious attempt to ship a large quantity of fresh fish, and that resulted disastrously, chiefly because of a lack of coöperation among the people handling the fish. A sailing ship with a quantity of ice was sent to bring a cargo of fresh fish from Mindoro. Owing to lack of ice, fish sufficient to make the voyage profitable could not be carried, although the fish shipped (*alces* or gray snappers) arrived in Manila in excellent condition. There is absolutely no reason why with proper care quantities of fine fresh fish could not be sent to Manila from numerous places such as Mindoro and Lingayen.

The results of some very interesting experiments in shipping fish have been published by the United States Bureau of Fisheries.[9] The results of these experiments show:

(*a*) That fish spoil more rapidly if the viscera are not removed.
(*b*) Free access of air retards putrefaction.
(*c*) Drainage of blood retards putrefaction.
(*d*) That if the intestines and head are removed and the fish is suspended by the tail so that the blood drains out, the fish will keep a considerable time without ice.

In 1908 a valuable paper[10] was presented to the International Fishery Congress regarding an improved method of packing fish. This method consisted in cleaning the fish thoroughly by removing the viscera and gills as soon as the fish

[9] Tower, Ralph W., Improvements in preparing fish for shipment, *Bull. U. S. Fish Comm.* (1899), 19, 231.

[10] Solling, A., An improved and practical method of packing fish for transportation, *Bull. U. S. Bur. Fish.* (1908), 28, pt. 1, 297.

were caught. They were then washed in salt water so that all the blood was removed. The water was then allowed to drain off, and the fish were wrapped in vegetable parchment called fish-wrapping paper. It is probable that the paper bags used for cooking in the United States could be used for this purpose where the regular fish-wrapping paper is not obtainable. It was found that the fish wrapped in this paper and put between layers of cracked ice (the pieces being about the size of a walnut) would retain their flavor and keep in sweet condition for a month or more, much longer than the fish prepared in the ordinary way. As the paper keeps the water out and prevents the fish from coming in direct contact with the ice, this system from a sanitary standpoint alone is to be strongly commended. It will be found that the fish keep and look so much better that they readily sell for a sum sufficient to pay for the paper and extra care.

ILLUSTRATIONS

PLATE I

FIG. 1. Landing fish at Tondo beach, Manila.
2. Fish spread on flakes for drying.

PLATE II

FIG. 1. Furnace for dipping sardines and herring.
2. Smoked herring, showing furnace and baskets in which the fish are smoked and the basket covers.

Fig. 1. Landing fish at Tondo Beach, Manila.

Fig. 2. Fish spread on flakes for drying.

PLATE I.

Fig. 1. Furnace for dipping sardines and herring.

Fig. 2. Smoked herring, showing furnace and baskets in which the fish are smoked and the basket covers.

PLATE II.

THE OSSEOUS SYSTEM OF OPHIOCEPHALUS STRIATUS BLOCH

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Nineteen plates and 7 text figures

In working out the internal skeleton of *Ophiocephalus striatus* Bloch, several specimens were dissected, although for the most part bones of a single individual have been used for purposes of illustrating the disarticulated bones. The bones of the skeleton of the fish represented in Plate I have been illustrated in this plate only, with the exception of a certain few, as for example anterior dorsal radials (85,115) shown in text fig. 2, the dorsal ray and internal spine, and the anal ray and interhæmal spine shown in text fig. 5.

In a few other instances bones of other individuals have been used; as, for instance, the glossohyal (65) shown in text fig. 7, the top of the skull, disarticulated, and a part of the suspensorium at the top of Plate VII.

The fish from the skeleton of which the illustrations of the disarticulated bones were made, with the exception of the few just named, was 50 centimeters long. Several smaller fish were also dissected, and the number of bones was found to vary considerably in specimens of different sizes. In several large individuals the total number of ribs varied from 41 to 45, the double ribs from 12 to 15, the vertebræ from 50 to 51, the interneural spines from 40 to 42, and the interhæmal spines from 23 to 25.

The character of certain bones in the larger specimen is very different from that of the bones of smaller fish. In small specimens the supraethmoid (75) and the glossohyal (65) are cartilaginous, and even in the largest specimen dissected the latter was found to be somewhat ossified in the central portion only. The partially ossified region is indicated in text fig. 7. With few exceptions the nomenclature of Starks[1] is here followed.

[1] *Proc. Wash. Acad. Sci.* (1901), 3, 507.

Plate I is taken from the left side of the whole skeleton of a fish 49.5 centimeters long. The numbers used in this plate to mark the bones are the same as are used in the individual descriptions throughout the paper.

I. THE SKULL AND ORBITALS

PLATES I, II, III, IV, AND V, AND PLATE VI, FIG. 1

The nasals (16) are somewhat rectangular, rather flat bones, with curved edges. Sensory canals pass from posteriorly anteriorly from the frontals (36) opening on the dorsal side a short distance from the anterior end. They articulate posteriorly with the frontals (36) and prefrontals (76), with the orbital (18[6]) outside, with the ethmoid (81) and supraethmoid (75) inside, with each other in front, and with the premaxillaries (1) below and anteriorly. Their curved interior sides form an opening through which project the dorsal side of the ethmoid (81) and the dorsal processes of the premaxillaries (1). (Plates I and II.)

The supratemporals (26) are somewhat right-triangular with the outward right angle slightly rounded off. They are perforated throughout the whole length by sensory canals. They lie above the articulation of the pterotics (38) and epiotics (79), and articulate with the parietals (37) anteriorly, while the posterior portion articulates with the base of the short spine of the posttemporals (27). (Plate II.)

The posttemporals (27) have a comparatively large oval body posteriorly, and anteriorly are widely forked, the larger branch, inside, articulating with the epiotics (79) and the shorter with the process of the pterotics (38). The posterior oval portion covers a part of the space between the opercles (14) and the epiotics (79). (Plates I and II.)

The supraoccipital (35) is situated between the parietals (37), about half of the upper surface extending anterior to them, and to which they are joined by broad flat condyles. The V-shaped anterior end is articulated with the frontals (36). Posteriorly it is joined to the exoccipitals (72) and the epiotics (79). Below it is joined to the proötics (78). The wide flat lateral processes form a part of the roof of the accessory branchial chamber. (Plate II; Plate IV, fig. 1; Plate V, fig. 1.)

The frontals (36) are somewhat rectangular, and twice as long as broad. They are extensively tunneled by sensory canals. The ventral side has an oblique ridge for articulation with

the basisphenoid (83) and the parasphenoid (66). They also articulate anteriorly with the nasals (16) and the prefrontals (76), outwardly laterally with the sphenotics (39), and with the ethmoid (81) anteriorly. Posteriorly they articulate with the pterotics (38). Just posterior to the ventral processes of the frontals, and lying close to them, the alisphenoids (122) are found. The oblique ridge-like ventral process of the frontals is continuous with the alisphenoids (122), and the somewhat flattened dorsal portion of the alisphenoids (122) lies against the flat ventral side of the frontals, posterior to their processes. In Plate II the frontals are seen from the dorsal side in the articulated top of the skull. In Plate III, disarticulated, the right is seen from the ventral side and the left from the dorsal. In Plate IV, fig. 2, the right frontal is seen from the right margin as also in Plate VI, fig. 1. In Plate V, fig. 1, they are seen in the articulated skull, from the ventral side. The left frontal is seen in Plate I.

The parietals (37) are roughly pentagonal in form, being almost flat—slightly convex above—and very thin. They articulate with the frontals (36) anteriorly, the supraoccipital (35) inside, the pterotics (38) outside, the epiotics (79) posteriorly, and form a part of the roof of the accessory branchial chamber. In Plate II the parietals are seen in the articulated skull from the dorsal side. In Plate III they are disarticulated, the right being seen from the ventral side and the left from the dorsal.

The pterotics (38) are somewhat rectangular in form, but with a spine-like process on the posteroexternodorsal side. The lower side has a ridge in the form of an arc, which bounds the portion serving as a part of the roof of the accessory branchial chamber. They articulate with the sphenotics (39) anteriorly, the parietals (37) inside, the epiotics (79) internally, and with the head of the hyomandibulars (10) below. The interno-posteroventral portion of the pterotics articulates with the externoanterior portion of the opisthotics (123). The pterotics are seen in Plate II from the dorsal side in the articulated skull. In Plate III they are disarticulated, the right being shown from the ventral side and the left from the dorsal side. The left is seen in Plate I. In Plate VI, fig. 1, the right pterotic is seen from the right side. In Plate V, fig. 1, the pterotics are seen from the ventral side in the articulated skull.

The sphenotics (39) are somewhat triangular and flat above, with a ridge below, slanting inward, which unites with the proötics (78). Internally and anteriorly the articulation is with

the frontals (36), and posteriorly with the pterotics (38). On the ventral side there is a fossa for the articulation of the anterior limb of the head of the hyomandibular (10). They are perforated throughout the whole length by the large sensory canals passing from the frontals (36). On the ventral side they articulate internally with the alisphenoids (122). In Plate I the left is seen. In Plate II both are viewed in position, from the dorsal side. In Plate III they are disarticulated, the right having the ventral surface in view, while the left, the dorsal surface. In Plate IV, fig. 2, the right is seen from the right side, as also in Plate VI, fig. 1. In Plate V, fig. 1, both are seen from the ventral side.

The parasphenoid (66) extends from about the median dorsal portion of the vomer (67) to almost the posterior portion of the basioccipital (69). It sends out lateral laminæ in the region of the proötics (78), and on the sides, in the region ventral to the basioccipital (69), are the posterior openings and grooves from the myodome. Ventrad to the basisphenoid (83) and anteriorly is another thin lamina on each side, which, together with the central "stock" or "rib," help to form the brain cavity. Anteriorly, the articulation is with the vomer (67) and the ethmoid (81), between which this portion lies. In Plate III the parasphenoid is seen from the dorsal side, disarticulated; in Plate IV, fig. 2, in the articulated skull from the right side; in Plate V, fig. 1, in the articulated skull from the ventral; and in Plate VI, fig. 1, in the articulated skull from the right side.

The vomer (67) anteriorly is broad with 2 triangular patches of teeth. Just back of this "head," there is a horizontal thin portion with a median rib, the latter extending to the posterior end. The dorsal outline is clearly shown in Plate III. It articulates with the ethmoid (81) dorsally, laterally with the prefrontals (76), and posteriorly with the parasphenoid (66). In Plate II the anterior end of the vomer is seen in the articulated skull; in Plate III the dorsal side in the disarticulated skull; in Plate IV, fig. 2, from the right side; in Plate V, fig. 1, in the articulated skull, from the ventral; and in Plate VI, fig. 1, in the articulated skull from the right side.

The basioccipital (69) forms the centrum of the condyle for the attachment of the atlas (70). There is a longitudinal suture separating it from the exoccipitals (72), and anteriorly a vertical suture separating the basioccipital and exoccipitals (72) from the proötics (78). The longitudinal suture between the basioccipital and exoccipitals (72) passes through the middle

of the auditory capsule. The dorsal side borders the foramen magnum. In Plate IV, fig. 1, it is seen from the dorsal side; in Plate IV, fig. 2, from the right side, articulated; in Plate V, fig. 1, in the articulated skull from the ventral side; and in Plate V, fig. 2, in the articulated skull from the posterior.

The exoccipitals (72) border the foramen magnum on the dorsal and internal side. A short distance within the foramen they unite as a narrow bridge of bone just dorsad to the bassioccipital (69), which latter forms the ventral side of the foramen at the posterior opening. The lateral portions extend outward and upward, articulating with the epiotics (79) laterally, with the supraoccipital (35) anteriorly above, with the proötics (78) anteriorly ventrally, and with the bassioccipital (69) below. The median portion of the dorsolateral process articulates with the ventral margin of the opisthotics (123). The exoccipitals are seen from the dorsal side of the articulated skull in Plate II; in Plate IV, fig. 1, disarticulated from other bones, from the dorsal; and in Plate V, fig. 2, in the articulated skull from the posterior. In Plate IV, fig. 2, and Plate VI, fig. 1, the right shows from the right side.

Otoliths (73). In a fish 50 centimeters in length, these are 18 millimeters long, 10 millimeters wide, and 3 millimeters thick. They are irregularly oval, somewhat curved, and on the convex side is a somewhat S-shaped groove over the whole length. In color they are like milky quartz, and there are concentric lines running about them like the rings of growth in the shell of the Pelecypoda. In Plate II the left, and in Plate III the right, is seen from the side fitting against the outer margin of the proötic (78), while in the same plates the other is seen from the inside or concave surface.

The supraethmoid (75) is a light, spongy bone, which in very young forms is cartilaginous. It is thickest posteriorly. The general form from the dorsal side can be seen very well in Plates II and III. It is situated dorsad to the anterior portion of the ethmoid (81) and the posterior portion of the head of the vomer (67). It is partly ventrad and partly posterior with respect to the dorsal processes of the premaxillaries (1). The supraethmoid, together with the dorsal processes of the premaxillaries, extend dorsally through the opening between the curved sides of the nasals (16).

Lying laterally to the ethmoid (81) and anteriorly to the frontals (36) are the prefrontals (76), somewhat wing-like laterally, and perforated anteriorly posteriorly by a large sen-

sory canal. In Plate II they are seen articulated from the dorsal side; in Plate III from the dorsal, disarticulated; and in Plate V, fig. 1, articulated, from the ventral side. In Plate IV, fig. 2, and Plate VI, fig. 1, the right is seen, articulated, from the right side. In Plate I the left is dimly seen.

In Plate V, fig. 1, the ventral side of the proötics (78) is shown in position. In Plate III the left is shown from the dorsal side, and the right from the ventral. In Plate IV, fig. 2, and Plate VI, fig. 1, the right is seen laterally. They articulate with the parasphenoid (66) ventrally and internally, the sphenotics (39) laterally, the alisphenoids (122) laterodorsally, the basisphenoid (83) interodorsally, the exoccipitals (72) posterodorsally, the basioccipital (69) posteriorly, and contain within them the otoliths (73). The form is shown in the illustrations. The myodome or chamber for the insertion of the rectus muscle of the eye is formed by projecting shelves of bone from the internal sides of the proötics, and is separated from the brain cavity by them. The basioccipital (69) also assists here. It is concave on the ventral side, forming a cavity with the parasphenoid (66). This cavity opens to the exterior by an opening on either side from above the posterior end of the parasphenoid (66).

The epiotics (79) articulate with the pterotics (38) on the outside, with the exoccipitals (72) on the inside, and internoanteriorly with the supraoccipital (35) and parietals (37). The main portion is somewhat pyramidal, with the base turned anteriorly and outwardly. Posteriorly and obliquely toward the spinal column is a broad expanse of thin bone about the same length as the main portion of the bone. This is somewhat fan-like with concentric rings. This thin expanse stands at almost a right angle to the body of the bone. As illustrated in Plate V, fig. 1, they articulate with the opisthotics (123) which overlie the posterolateral portion of the ventral surface of the epiotics. They are seen in Plate II, articulated, from the dorsal side; in Plate V, fig. 1, the posterior fan-like expanse from the ventral side; and in Plate V, fig. 2, is the posterior view. In Plate IV, fig. 1, the right is displayed from the dorsal side, while the left has the ventral side uppermost. In Plate IV, fig. 2, the right side of the posterior portion of the right bone is visible.

The ethmoid (81) is somewhat oval above, with two lateral processes dorsally which articulate with the nasals (16). Laterally it articulates with the prefrontals (76), posteriorly with the frontals (36), and ventrally with the parasphenoid (66) and

the vomer (67). Anteriorly are 4 cartilaginous projections, 2 in front and 1 at each side, and posteriorly 1 cartilaginous projection, which aid in articulation. These projections are shown in the illustration. Ventrally the ethmoid is a much narrower oval, and the thin median ventral portion overlies the median parasphenoid (66) anteriorly. The whole bone is very porous, especially the laterodorsal portions. It is visible from the dorsal side, articulated, in Plate II, and disarticulated in Plate III.

The basisphenoid (83) has rather thick lateral wing-like processes, which are slightly wider anteriorly than posteriorly, and there is a short spinous portion posteriorly that fits into a longitudinal slit-like fossa in the dorsal side of the parasphenoid (66). The lateral portions articulate with the ventral ridges of the frontals (36) and the alisphenoid (122) and slightly with the anterior portions of the proötics (78). Plate III shows it from the dorsal side; Plate IV, fig. 2, shows the anterior process of the right side; and Plate V, fig. 1, the anterior process of the left side—that of the right side not being visible here.

The alisphenoids (122) articulate with the frontals (36), laterally and dorsally, interoventrally with the basisphenoid (83), posteroventrally with the proötics (78), and laterally with the sphenotics (39). They lie close against the ventral side of the frontals, and closely posterior to their ventral process. On the dorsal side there is a flange supporting them against the ventral side of the frontals (36). They are porous and somewhat perforated with sensory canals. They are shown in position in Plate V, fig. 1, from the ventral side, while in Plate III that of the right side is shown from the ventral side, disarticulated, with the outer margin toward the inside of the plate.

The opisthotics (123) articulate with the exoccipitals (72) and pterotics (38), overlying the space between the two bones named and covering the epiotics (79) on the ventral side. They are seen in Plate IV, fig. 1, the right being shown from the dorsal side, while the left is shown from the ventral side. In Plate V, fig. 1, both are seen from the ventral side in position, and in Plate V, fig. 2, the view is from the posterior. In Plate VI, fig. 1, the right is seen from the right side. They are somewhat triangular, porous, and perforated by sensory canals. These, together with parts of the epiotics (79), inclose a small cavity in the ventral side of the latter.

Suborbitals and preorbitals, 18^{1-6}. The suborbitals are 18^{5}, 18^{4}, 18^{3}, 18^{2}, and 18^{1}; and 18^{6} is the preorbital. These are all

shown in Plate VI, fig. 2. At the right in the top line all are shown united, while at the left in the same line the bones are shown separately, with the 4th suborbital, 18^2, seen from the posterior side showing the flange that forms the posterior side of the orbit. Those in the lower row are seen from the left side and from the outer—lateral—side. All of the orbitals are perforated by sensory canals almost continuously and with various openings to the exterior. Anteriorly and posteriorly the articulation is with the frontals (36), while 18^2–18^6, inclusive, closely overlie the maxillaries (5). Those at the right, united, are from a somewhat smaller fish than those disarticulated. They are also illustrated in Plate I.

II. SUSPENSORIUM AND OPERCULAR APPARATUS

PLATES VII AND VIII

The palatines (2) articulate anteriorly with the vomer (67), with the pterygoids (80) posteriorly, and the mesopterygoids (71) dorsally. The anterior process of the palatines passes dorsally over the maxillaries (5), articulating with them. The palatines are continuous with the pterygoids (80) and the quadrates (7). The posterior portion of the palatines lies interior to the maxillaries (5). The exterior side is shown in Plate VII and the interior side in Plate VIII.

The quadrates (7) are almost right-triangular in form, the right angle being ventral. Anteriorly there is a broad, flattened portion, articulating with the pterygoids (80) and the mesopterygoids (71) and dorsally with the metapterygoids (8). The posterior portion, which is in the form of a broad flat spine at right angles to the anterior portion, projects posteriorly into a fossa in the lower anterior portion of the preopercles (11). On the inside, between the anterior and posterior parts, is a groove, at the bottom of which is a fossa into which the lower spinous portion of the symplectics (9) fits. The wide portion at the right angle articulates with the posterior end of the angulars (12). Plate VII shows the quadrates from the exterior side both articulated and disarticulated, while Plate VIII exhibits them from the internal side.

The metapterygoids (8) articulate with the mesopterygoids (71) anteriorly, the quadrates (7) ventrally, the symplectics (9) posteriorly, and with the hyomandibulars (10), the frontals (36), and the sphenotics (39) dorsally. From the center of the posterior somewhat square portion there arises an oblique ridge

on the inside, which passes along the inside of the hyomandibulars (10). The outside of the right bone is shown in Plate VII and the inside in Plate VIII. The left is also included in Plate I.

The symplectics (9) consist of a somewhat curved central triangular portion with the base upward, and anteriorly and posteriorly from this extends a wing-like process. They articulate with the metapterygoids (8) anteriorly, while the pointed ventral portion becomes ankylosed with the inside of the quadrates (7). They are little more than laminate in the central triangular portion only. The outside of the bone on the right side is shown in Plate VII, and the inside of the bone on the left side of the head is shown in Plate VIII. The left is also included in Plate I.

The hyomandibulars (10) consist of a somewhat columnar head or dorsal portion, from which there projects a ventral lamellar portion, reënforced in the middle region by a thickened triangular area similar to that of the symplectics (9) with which this portion of the hyomandibular articulates. From this lateral part of the bone there projects, at right angles, into the region of the accessory branchial chamber, a lamellar portion, internally, which assists in supporting the membranes there. The anterior portion of the head of the hyomandibulars fits into a groove on the ventral surface of the sphenotics (39), the posterior portion fits into a similar but shallower fossa on the ventral surface of the pterotics (38), while the posterior end of the head fits into the socket on the inner, anterior, upper portion of the opercle (14). Ventrally they articulate with the symplectics (9) and the metapterygoids (8), with the interhyals (21) internally, and with the preoperculars (11) posteriorly. They are perforated with canals continuous with those of the preoperculars (11). The outside of the bone of the right side is shown in Plate VII, and the inside of the bone on the left side is shown in Plate VIII, while the left is seen in Plate I.

The outline of the preopercles (11) is clearly shown in the plates. Plate VIII shows the inside of the bone on the left side, and Plate VII the outside of the bone on the right side. They articulate with the hyomandibulars (10), the symplectics (9), and the quadrates (7) anteriorly, with the operculars (14) posteriorly, and the interoperculars (40) on the inside posteriorly. On the inside they articulate with the interhyals (21), which lie vertically on the preopercles (11). They are perforated throughout the whole length by sensory canals.

The subopercles (13) articulate with the opercles (14) dorsally, the angle following the lower margin of the same and overlapping slightly on the inside. Ventrally and anteriorly they articulate with the interopercles (40), and the anterior dorsal process lies on the inside of the median portion of the preopercles (11). They are lamellar throughout except for a slight perforated thickening anteriorly and dorsally, and are convex on the outside. The inside of the bone on the left side is shown in Plate VIII, and the outside of the bone on the right side is shown in Plate VII. In Plate VI, fig. 1, the posterolateral margin of the left is seen from the inside. In Plate I the left is shown from without.

The opercles (14) are roughly right-triangular with the right angle anterior and dorsal, and are convex outwardly. They are thickly lamellar with reënforcements along the anterior margin, dorsoanteriorly, and with a ridge running anteriorly posteriorly about one-third of the distance from the dorsal margin, along the inside. This ridge continues anteriorly in a large expanse, concave anteriorly, which serves for the socket of the posterior end of the head of the hyomandibular (10). The opercles appear to be made up of a considerable number of concentric rings like the shell of the Pelecypoda, with the center, corresponding to the umbo of the shell, just inside the socket for the articulation of the posterior end of the head of the hyomandibulars (10). The inside of the bone on the left is shown in Plate VIII, and the outside of the bone on the right side is shown in Plate VII. In Plate VI, fig. 1, a part of the inner surface of the left is in view. The left is also seen in Plate I.

In Plate VIII the left interoperculum (40) is shown from the interior and in Plate VII the right from the exterior. In Plate VI, fig. 1, the inner ventral margin of the left may be seen, and in Plate I the left is viewed. The interopercula overlie the branchiostegal rays (22) and a portion of the epihyals (20), and also posteriorly they overlie the anterior margin of the subopercles (13). The dorsoanterior portion lies internally with respect to the ventral part of the preopercles (11), with which they articulate. The dorsal process overlies the epihyals (20). Posteriorly the interopercles are somewhat lamellar, while the anterior portion, as also the dorsal process, is somewhat thickened. Anteriorly they articulate with the posterior portions of the angulars (12) and the articulars (4).

The mesopterygoids (71) are thin wing-like bones, somewhat convex on the outside, and about twice as long as broad. They

articulate forward and on the outside with the palatines (2), on the lower side with the pterygoids (80), posteriorly and ventrally with the palatines (2), on the lower side with the pterygoids (80), posteriorly and ventrally with the quadrates (7), and posteriorly with the metapterygoids (8). They are about as long as the palatines and about three-fourths as long as the frontals (36). The outside of that of the right side is represented in Plate VII and the inside of the left in Plate VIII.

In Plate VIII the interior side of the left pterygoid (80) is shown, and in Plate VII the exterior of the right. They articulate with the palatines (2) anteriorly, the posterior ends of which extend into the anterior fossa in the pterygoids. The posterior end lies inside of, and articulates with, the anterior portion of the quadrates (7). The ventral margin of the mesopterygoids (71) lies internally to, and articulates with, the interior and dorsal margin of the pterygoids. The anterior spinous portion lies along the dorsal side of the palatines (2). At the top of Plate VII the pterygoid is seen still articulated.

III. MANDIBLE

PLATE IX

The premaxillaries (1) are curved and tapering from the middle region posteriorly, where they are cartilaginous and almost spinous. At the anterior end is a dorsal process divided into two parts, the more anterior being the higher. The shorter sets just below the nasals (16), while the longer passes dorsally through the opening between the nasals (16) and anteriorly to the supraethmoid (75). The teeth anteriorly on the ventral side are moderately large, while those posteriorly are very fine. On the inside margin of the posterior two-thirds is a ridge of cartilage which is continuous with a short ridge-like process of bone, originating a short distance posterior to the dorsal process. The premaxillaries articulate with the maxillaries (5) anteriorly and posteriorly, lying ventrad to them. They articulate with each other anteriorly, and the higher dorsal process at the anterior end of each overlies the anterior surface of the supraethmoid (75). They lie laterad of the palatines (2) and the pterygoids (80), and the anterior end of each overlies the vomer (67). (Plate 1; Plate VI, fig. 1; and Plate IX.) In Plate IX the dorsal side of the left and the central side of the right are exposed. The left is also seen in Plate I.

The left and right dentaries (3) are shown from the dorsal side and the outer lateral side, respectively. They dovetail

into the articular (4) posteriorly, and articulate with each other in front. There is a deep fossa extending anteriorly into the dentaries, opening toward the inside posteriorly, into which the outer longer portion of the articular (4) extends. There is also a canal on the inside of the furrow, leaving two openings anteriorly, one on the ventral side and the other forward on the outside.

There is a single row of large conical teeth extending for a part of the length of the dentaries but not continuing either entirely anteriorly or posteriorly, while posterior to these large teeth are some smaller conical teeth. Anteriorly is a mass of cardiform teeth. Also on the outside of the large teeth is a row of the very small conical teeth, and some of them have still smaller teeth at their bases on the inside. (Plate I and Plate IX.)

The articulars (4) articulate anteriorly with the dentaries (3) and with the quadrates (7) and with the angulars (12) posteriorly. They form an obtuse angle at the outer lower margin, with a high dorsal process at the outer posterior part. Anteriorly are two processes, the outer being the longer and sharper. These two articulate with the dentary (3), the outer and longer process extending into the fossa of the dentary (3) and the other lying along the inside of the dentary (3). The sensory canal in the dentaries (3) is continuous with a similar canal in the articulars. In the depression continuous with that formed by the union of the two anterior processes is a small scale-like bone, the intra-articular (86). (Plates I and IX.)

The maxillaries (5) extend inside the suborbitals (18) just above the premaxillaries (1), articulating with them anteriorly and posteriorly, and the dorsal process fits in between the dorsal processes of the premaxillaries (1) and the anterior processes of the palatines (2). Posteriorly they extend as far as the posterior end of the articulars (4) and the dorsal angle of the quadrates (7). The dorsal view of the left is shown in Plate IX, as is also the ventral view of the right, and in Plate I the left is displayed.

The angulars (12) articulate closely with the posterior inner end of the articulars (4) and with the interopercles (40) posteriorly. The dorsal side of the left is shown disarticulated from the articular (4) and the right still articulated. (Plate IX.)

These "intra-articulars" (86) lie in the angle of the articulars (4). In Plate VI that of the right side is seen detached, from

the dorsal side, and the left is seen still lying in the angle of the left articular (4). The ventral side is flattened, while the dorsal is somewhat conical. They lie with the median portion opposite the attachment of Mackel's cartilage with the articulars (4). This name is here given because of the location.

IV. PECTORAL AND PELVIC GIRDLES

PLATE X

At the left of Plate X is the left clavicle (62), with the dorsal portion of the postclavicle (77), the hypercoracoid (15), and the hypocoracoid (30) attached, and seen from the inside. Toward the right is the right clavicle, seen from the outside, and disarticulated. The two clavicles articulate together forward and ventrally, then pass posteriorly diagonally toward the dorsal side, and lie along the interior side of the interopercles (40), the subopercles (13), and the opercles (14). The dorsal portion of the clavicles is articulated with the supraclavicles (28). (Plates I and X.) The dorsal end of the clavicles, which is seen toward the bottom of the plate, is somewhat lamellar, but is reënforced posteriorly by a considerable thickening, continuous with the thickening of the middle part of the bones passing upward from the ventral expanded condyles. From the middle portion extends a somewhat lamellar portion, convex anteriorly and concave posteriorly. Within this concavity the hypercoracoid (15) and the hypocoracoid (30) are articulated. The anterodorsal spinous process extends interiorly to the posterior end of the supraclavicles (28). The posterior expanse or wing of the right clavicle, which aids in the articulation of the hypercoracoid (15) and the hypocoracoid (30), is seen a short distance from the dorsal end.

The interior side of the left supraclavicles (28) is shown on the left of Plate X, while that of the right side is seen from the outside. The anterior end articulates with the ventral side of the body of the posttemporal (27). The supraclavicles extend backward along the inside of the opercles (14) and along the outside of the dorsal portion of the clavicles (62) with which they articulate. Along the inside at the dorsal margin there is a fossa which looks as if formed by the rolling over of the dorsal margin. The condyle at the anterior end is somewhat hooked externally, as is shown especially in the bone of the right side. The left is also indicated in Plate I.

Postclavicles, lower part (6). These, as well as the upper part of the postclavicles (77), are lamellar. The upper one-

third of the lower part lies over or outside of the upper part (77). The form is well shown in Plate X. On the right side of the plate the upper part (77) and lower part lie separately. On the left side of the plate the parts of the left postclavicle overlie the inside of the clavicle (62), the hypercoracoid (15), and the hypocoracoid (30).

The postclavicle, upper part (77), articulates with the posterior upper expanse of the clavicles (62), and lies almost parallel with it. The lower end articulates with the lower part of the postclavicle (6). This part of the postclavicle also is lamellar, and the form can be readily seen in Plate X.

On the left side of Plate X the inside of the bases of the pectoral rays (29) of the left side is shown, while on the right side of the plate are the pectoral rays of the right side. These articulate with the actinosts (31) in each fin. In Plate I the left pectoral is present. The number of rays articulating with each of the actinosts may be determined from the plate.

The pelvic rays (33) are attached to the pelvic girdle (32), and are shown in Plate X and, also, in Plate I.

The hypercoracoids (15) are somewhat roughly quadrangular bones, articulating with the actinosts (31), the hypocoracoids (30), and the clavicles (62). In Plate X the left is shown articulated with the hypocoracoid (30) and the clavicle (62), while on the right side it is isolated. Each is pierced by a large foramen. The edge articulating with the actinosts (31) is much thickened, while the remainder is very thin, being thinnest around the foramen. The dorsal portion of the hypocoracoids extends inward at an angle to conform to the interior of the clavicles (62). The left is indicated in Plate I.

The hypocoracoids (30) are articulated with the clavicles (62) anteriorly by two processes, with the two ventral actinosts (31) posteriorly, and with the hypercoracoids (15) dorsally. In Plate X the left hypocoracoid is seen at the left side, internally, with the ventral portion of the postclavicle (6) lying over it, and articulated with the hypercoracoid (15) and the clavicle (62). On the right side the right hypocoracoid is shown from the outside. Interiorly the ventral portion has an angular furrow, at the bottom of which is the prolongation of the ventral process seen at the top in the plate. The sides of the furrow are lamellar. The dorsal portion is lamellar with a considerable thickening at the region of articulation with the actinosts (31). In Plate I the posterior and ventral portions are to be seen.

The actinosts (31) are 4 in number on each side. The most

ventral articulates anteriorly with the hypocoracoid (30), the next articulates with the hypocoracoid (30) and the hypercoracoid (15), and the 2 dorsal ones articulate with the hypercoracoid (15), while posteriorly all articulate with the pectoral rays (29). The condyles are much thickened, being about 1.5 millimeters, while between them the bones are about 0.5 millimeter. The epicondyle of the ventral actinost is very thin. The actinosts are found in Plate X, and are shown from within, the left actinosts being at the left side. The right actinosts are represented from the outside. The left actinosts may also be seen in Plate I.

The pelvic girdle (32) is united anteriorly with the ventral portions of the clavicles (62) by ligaments, and is separated from them a distance about two-thirds its length. The posterior condyles of the two parts of the girdle are much thickened to articulate with the anterior ends of the pelvic rays (33). The right and left parts are shown from the dorsal side in Plate X, and the left part from the left side in Plate I.

FIG. 1. Caudal vertebra, the last but 2 (131), anterior view. × 2.

V. VERTEBRÆ, RIBS, AND HYPURALS

PLATES XI AND XII

The first 3 vertebræ have no transverse processes (46, 47). From the 4th to the 8th they grow longer and extend farther laterally, although they immediately begin to slant ventrally, so that a little posterior to the median abdominal region they are almost vertical. The fossæ of the transverse processes of the 3d, 4th, and 5th ribs are turned dorsally, then in the succeeding ribs they begin to turn more and more posteriorly, until in the 18th vertebra they face posteriorly.

The first 2 vertebræ, atlas and axis, receive the articulation of a pair of single ribs, the succeeding 15 vertebræ the articulation of a pair of double ribs, and the remainder, except the last 5 vertebræ, have a pair of single ribs articulated.

In Plate XI the atlas (70) is seen from the posterior side and slightly tilted posteriorly, showing the centrum, neural arch, and neural spine. It is seen also in text fig. 2.

The axis (87) is seen from the posterior, showing the centrum,

neural arch (126), and neural spine (43). (Plate XI.) This is seen also in text fig. 2.

The 5th vertebra (88) of the spinal column is here seen posteriorly. It shows the neural spine (43), neural arch (126), centrum, and transverse processes (46). The last are here horizontal, and receive the articulation of a pair of double ribs. (Refer to Plate XI.) The neural spine of this vertebra may be seen in Plate I.

The 6th vertebra (89), 6th of the spinal column, seen from the left side shows the neural spine (43), while the transverse processes are over the body of the vertebra. Prezygapophyses (127) and small postzygapophyses (128) are seen. This is shown in Plate XI from the left side, and the neural spine is indicated in Plate I.

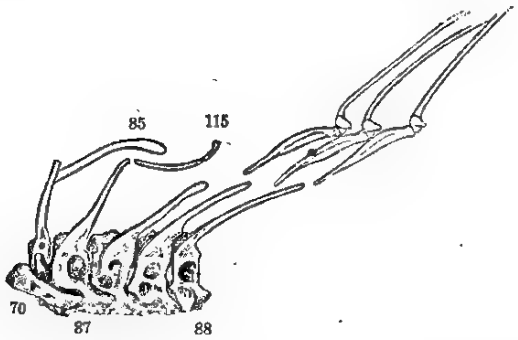

FIG. 2. Atlas (70); axis (87); 3d, 4th, and 5th vertebræ; interneural spines; dorsal rays; and anterior dorsal radials (85 and 115). Natural size.

The 7th vertebra (90) (42 in Plate I) is seen from the anterior side, showing the neural spine (43), the transverse processes (47), the neural arch, and the centrum (97). This is indicated in Plate XI and, also, in Plate I.

The 20th vertebra (91), from the posterior side in Plate XI, shows the transverse process (49), the neural spine (43), the neural arch, and the centrum (98). Transverse processes are here passing toward the vertical. Plate I also shows this vertebra from the left side.

The 21st vertebra (92) is viewed from the left side. It shows the prezygapophysis (127), the postzygapophysis (128), neural spine (125 and 43), and the transverse process (49). The transverse processes approach more nearly the vertical. Plates I and XI illustrate this vertebra.

The 22d vertebra (93) shows the neural spine (43), centrum

(99), and transverse process (49). It is viewed from the anterior side in Plate XI. In Plate I the left side is shown.

The 7th vertebra (94) from the last, in Plate XI, is viewed from the posterior side showing the neural spine (43), neural arch (126), and centrum (100). It is also seen, articulated, from the left side in Plate I.

The 6th vertebra (95) from the last shows the neural spine (43, 125), prezygapophysis (127), and postzygapophysis (128). This is viewed from the left side. Plate XI represents it from the left side disarticulated, and Plate I, articulated.

The 5th vertebra (96) from the last is viewed from the anterior side in Plate XI, showing the centrum (101), the neural spine (43), and the neural arch. Also, Plate I shows it, articulated, from the left side.

The last caudal vertebra but 4 (129) illustrated in Plate XII, fig. 2, shows a neural spine (51), hæmal spine (52), prezygapophysis, postzygapophysis, anterior ventral process, and lateral foramina, being seen from the left side.

The last caudal vertebra but 3 (130) in Plate I and Plate XII, fig. 2, shows the same parts as 129, but with much longer neural (51) and hæmal (52) spines.

The last caudal vertebra but 2 (131) in Plate I and Plate XII, fig. 1, shows the same structures as number 129, but the neural and hæmal spines arise from the middle and anterior portion of the centrum of the vertebra. Also, there is a dorsal process on the hæmal spine a short distance from the centrum. This process on the dorsal side of the hæmal spine (52) helps to articulate with the detached hæmal spine (52) of the last caudal vertebra but 1 (132). The anterior side is illustrated in text fig. 1.

The last caudal vertebra but 1 (132) bears the neural spine (51), prezygapophysis, and hæmal spine (52), the last being detached. This last contains the hæmal arch within itself. In Plate I this is seen in the articulated skeleton, and in Plate XII, fig. 1, it is disarticulated, with the hæmal spine (52) detached.

The hypural vertebra (34) is the last vertebra, and articulates with all of the hypurals except 102 and 103, dorsally, posteriorly, or ventrally. Anteriorly it articulates with the next vertebra. The posterior dorsal process receives the condyles of the hypurals (53) in its deep ventral fossa. It bears prezygapophyses (?) which extend dorsally, and the posterior ventral process is at the extreme posterior ventral margin. Plate I and

Plate XII, fig. 1 (the articulated skeleton), illustrate this vertebra from the left side.

Suspended above the anterior end of the spinal column are the two anterior dorsal radials (85, 115). In Plate I, as also in text fig. 2, they are represented in their natural positions. It will be observed that the convex side of the first (85) is dorsal, overlying the neural spine of the axis, while the concave side of the second (115) is dorsal, and overlies the neural spine of the third vertebra.

Neural spine 41 is somewhat posterior to the median abdominal region.

Neural spine 43 is the spine of the 7th vertebra, bearing Nos. 42 and 90 in Plate I, while in Plate XI it represents the neural spines of all the vertebræ illustrated.

Neural spines 51 are shown in Plate I and in Plate XII, fig. 1; the latter are the neural spines in the caudal region. In Plate XII, fig. 1, the vertebræ are disarticulated, while Plate I shows them articulated.

Neural spines 125 are of vertebræ 92 and 95. Other neural spines are No. 43. These are illustrated in Plates I and XI.

The neural arch (126) is of the vertebra that is the last but 7, No. 94, and of the 2d and 5th vertebræ, Nos. 87 and 88, in Plate XI.

Hæmal spines (52). In Plate I the vertebræ are articulated, and in Plate XII, fig. 1, they are disarticulated. It will be noted that the hæmal spine of the last vertebra but 1 is disarticulated from the centrum.

Transverse process (46). This number indicates the transverse process of the 5th vertebra, No. 88. Plate XI.

Transverse process (47). This is on the 7th vertebra, Nos. 90 and 42. Plate XI.

Transverse process (49). This number indicates the transverse process on the 21st vertebra, No. 92; and on the 22d vertebra, No. 93; and also in Plate I it indicates the transverse process on the 25th vertebra. (Plate XI.)

The prezygapophyses (127) are illustrated in Plate XI, the 21st vertebra being No. 92; and in the last vertebra but 6, No. 95.

The postzygapophyses (128). These are designated in Plate XI in the 6th vertebra, No. 89; the 21st vertebra, No. 92; and in the last vertebra but 6, No. 95.

The anterior ventral process (134) and the posterior ventral

process (135) are used in Plate XI in describing the last vertebra but 6, No. 95.

The hypurals (53) articulate anteriorly with the hypural vertebra (34) and posteriorly with the caudal rays (54, 55). The second from the ventral has its anterodorsal processes designated No. 60. No. 124 lies over the anterior end of the dorsal broad hypural articulating with it, joining this hypural with the dorsal surface of the hypural vertebra (34). The second broad hypural from the dorsal side articulates with the posterodorsal process of the hypural vertebra (34), the next 3 hypurals with the posterior surface of the hypural vertebra (34), while the last broad hypural, or that bearing the process No. 60, articulates with the posterior surface of the hypural vertebra, the two anterodorsal processes passing dorsally at the sides. Lying along the most dorsal broad hypural is the narrow hypural (102), and below the most ventral broad hypural is also a narrow hypural (?) (103), very similar to 102. (Plates I and XII.)

The anterodorsal processes (60) of the most ventral wide hypural (53) pass off from the anterior dorsal surface of the most ventral wide hypural, extending laterally around the hypural and hypural vertebra (34) lying dorsally, and really forming the hæmal arch. The dorsal tips of these processes lie at a considerable distance from the hypurals (53) above, embedded in the muscle. (Plate I and Plate XII, fig. 1.)

Hypural (?) No. 102 articulates with the anterior portion of the most dorsal broad hypural (53) and with the neural spine of the vertebra that is the last but one. It is of a form similar to the neural spines of the four vertebræ anterior to the hypural vertebra, but in thickness, color, and certain other characteristics it resembles the other hypurals (53) although being narrower. It lies between 124 and the body of its hypural (53) and the neural spine of the vertebra that is the last but one, and articulates with them. In Plate I it lies in articulation, while in Plate XII, fig. 1, it is disarticulated.

Hypural (?) No. 124 is the anterior detached portion of the most dorsal wide hypural (53). This bone receives, in the fossa on the ventral side, the anterior dorsal portion of the first broad hypural (53) and articulates with the hypural vertebra (34) ventrally and with the neural spine (51) lying in front. With the neural spine (51) just in front, it forms an arch dorsad of the body of the hypural vertebra (34). Plate

I illustrates it still articulated, while Plate XII, fig. 1, represents it detached.

Rays of caudal fin No. 54 articulate with the posterior ends of the hypurals (53) clasping around them and on the dorsal side with the neural spines (51) of the 2 vertebræ immediately preceding the hypural vertebra (34). On the ventral side they articulate with the hæmal spines (52) of 3 caudal vertebræ immediately preceding the hypural vertebra (34). (Plate I.) No. 55 is used in Plate I to indicate the caudal rays at the dorsal side. These are short, those in the median region being the longest, the fin being homocercal.

RIBS

Articulated with the atlas and axis is a pair of single ribs. Posterior to these are about 15 pairs of double ribs, while posterior to these there is a pair of single ribs articulated with each of the vertebræ except the last 5 in the caudal region. In the last 4 pairs of double ribs the more dorsal is articulated to the transverse process, not at the place with the ventral, but slightly proximally, and so may be designated epipleurals. The last 3 double ribs in Plate I show this condition.

Rib 48 is in the anterior abdominal region in Plate I.

Rib 50 is attached to the 28th vertebra as shown in Plate I.

Rib 56 is in the posterior abdominal region, and is articulated with the 38th vertebra. (Plate I.)

Ribs 59 are the ventral of the first 3 double ribs, those of the right side lying above. They are articulated with the 3d, 4th, and 5th vertebræ, respectively.

Ribs 61 are the dorsal of the first 3 double ribs. These are articulated with the 3d, 4th, and 5th vertebræ. (Plate XII, fig. 2.)

The 13th upper double rib (104). All of these ribs at the bottom are of the left side of the body, and those at the top of the right side. Plate XII, fig. 2.

The 13th lower double rib (105) is seen in Plate XII, fig. 2.

The 14th upper double rib (106) is seen in Plate XII, fig. 2.

The 14th lower double rib (107). Anteriorly to this point, the dorsal ribs have been the longer. (Plate XII, fig. 2.)

The 15th upper double rib (108). Here the lower instead of the upper double rib is the longer. (Plate XII, fig. 2.)

The 15th lower double rib (109) is in Plate XII, fig. 2.

The 25th rib (110) of the trunk is a single rib, and is illustrated in Plate XII, fig. 2.

The 26th rib (111) of the trunk is shown in Plate XII, fig. 2.

The 39th rib of the trunk (112), a single rib, is illustrated in Plate XII, fig. 2.

The 40th rib (113) is shown in Plate XII, fig. 2.

The 41st rib (114) is represented in Plate XII, fig. 2.

VI. HYOID APPARATUS

PLATE XIII

Plate XIII shows the hyals from the outside, except the urohyal (68), which is seen from the ventral side. On the left side of the plate the hypohyal (84), the ceratohyal (19), and the epihyal (20) are shown articulated, while on the right side they are shown disarticulated.

The ceratohyal (19) is shown in the natural size, the anterior end being 4.5 millimeters in thickness and the posterior end 3 millimeters. Along the exteroventral margin is a fossa for the articulation of the branchiostegals (22).

The flange on the ceratohyal is seen not to be continuous with that of the epihyal (20). The first and second branchiostegals (22) are articulated with the ceratohyal, and the end of the third is opposite the V-shaped opening on the ventral side between the pterygoid (80) on the outside and the urohyal (68) on the inside. The ends are much splintered, especially the posterior end. These are also seen from the dorsal side in Plate XV.

The outline of the epihyals (20) is clearly seen in Plate XIII. The ventral side has a wide flange similar to that on the ceratohyals (19) for the articulation of the branchiostegals (22). The posterior end has a condyle 4 millimeters thick. The anterior end is splintered with a very large process or "splinter" on the ventral side, which fits into a fossa in the posterior end of the ceratohyal (19).

The end of the third branchiostegal ray overlies the V-shaped interruption between the ceratohyals (19) and the epihyals on the ventral side, and the 4th and 5th rays articulate with the flange of the epihyals. Dorsally, at the extreme posterior end, the epihyals articulate with the ventral end of the interhyals (21). The epihyals lie opposite the posterior end of the quadrates (7), the ventral end of the preopercles (11), and the dorsal anterior portion of the interopercles (40). The dorsal portion of the extreme posterior end lies at the side of the

ceratobranchials (63) of the first branchial arch. In Plate XIII the exterior side of the bones is shown at the right and left sides. They are also seen from the dorsal side in Plate XV.

In Plate XIII the anterior side of the interhyals (21) lies in view. The condyle of the ventral end is larger than that of the dorsal end, and articulates with the glenoid fossa of the epihyals (20). The epicondyle, which here lies below, in its natural position is toward the interior. That of the left side is indistinctly seen in Plate XV.

The branchiostegals (22) are seen from the exterior and are curved as shown in Plate XIII. The anterior two articulate with the ceratohyals (19), the 3d lies over the V-shaped in-

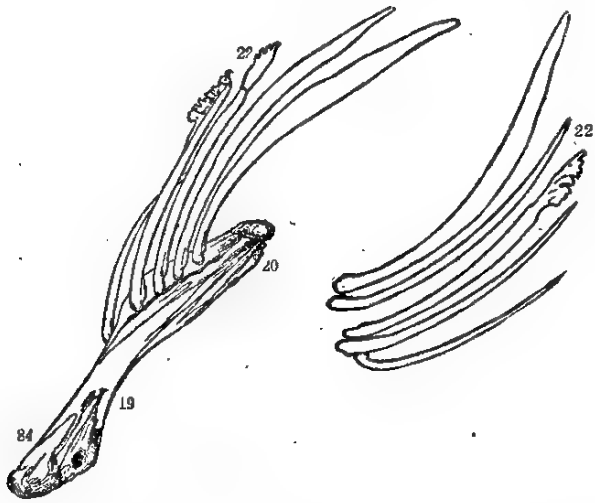

FIG. 3. Hypohyals (84), ceratohyals (19), epihyals (20), and branchiostegal rays (22). "Teeth" are found on some of the rays. Natural size.

terval between the ceratohyals (19) and the epihyals (20), and the 4th and 5th articulate with the epihyals (20). They lie opposite the inner surfaces of the interopercles (40), the subopercles (13), and the opercles (14). In one specimen examined, the 2d and 3d branchiostegals on the right side are seen to be notched or toothed as shown in text fig. 3, and on the left side the third is of like structure. In Plate XI the branchiostegals are in position, and the extended epibranchials (64) and superior pharyngeals (23) are underneath the posterior ends. Plate VI, fig. 1, shows those of the left side from the interior.

From the ventral side the urohyal (68) presents a flat, somewhat oval surface, with a posterior spinous portion. However,

the median line and the seeming posterior portion indicate the presence of a dorsal lamellar flange at right angles to the part shown. The anterior view shows the urohyal to be somewhat like an inverted T seen in text fig. 4. Anteriorly, both the horizontal and vertical lamellæ are thickened, so that the anterior end is of the shape shown in the figure. It articulates by the anteroventral fossa with the ventral side of the second basibranchial (17). Laterally and anteriorly it lies between, and articulates with, the hypohyals (84) and continues posteriorly between the ceratohyals (19) and the branchiostegals (22). (Plates VI and XIII.)

The hypohyals (84) articulate with each other just anterior to the urohyal (68) and with the anterior portion, both horizontal and vertical, of the urohyal. Posteriorly they articulate with the ceratohyals (19). Dorsally they articulate with the first basibranchial (17) and also with the ventral vertical ridge of the same. On the left side the hypohyal is still articulated with the ceratohyal (19), while on the right side the right hypohyal is disarticulated. These are seen from the outer side. In Plate XV the posterodorsal condyles articulate with the second basibranchial (17) internally. The hypohyals are perforated with sensory canals. These are illustrated in Plate VI, fig. 1, and Plates XIII and XV.

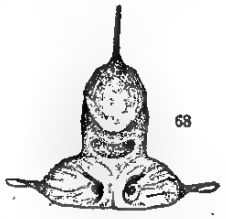

FIG. 4. Urohyal (63), anterior view. × 8.

VII. DORSAL RAYS AND INTERNEURAL SPINES AND ANAL RAYS AND INTERHÆMAL SPINES

The interneural spines and the interhæmal spines articulate with the dorsal rays and anal rays, respectively, by ball-and-socket joints. Between the two lateral parts of the rays at the proximal ends are situated small spherical bodies (cartilaginous nodules) which fit into the sockets at the distal ends of the spines. In Plate XIV one of those posteriorly in the anal fin is seen disarticulated and others in both fins are plainly visible. Certain of the rays in both dorsal and anal fins present the posterior view, which shows the two lateral parts of the rays, their partial separation at the proximal end, and the cartilaginous nodules lying between their proximal ends.

All of both the interneural and interhæmal spines are represented from the left side, the left side of the plate being anterior. The posterior dorsal rays are not represented.

The form, outline, and articulation of the dorsal rays and the interneural spine, as well as the same characters of the anal rays and interhæmal spines, are shown in text fig. 5.

The interneural spines (44) of the anterior abdominal region are illustrated in Plate I, and in Plate XIV they are disarticulated.

Dorsal ray (45). In Plates I and XIV this number indicates the 8th dorsal ray, shown from the left side.

Dorsal ray (116). This is the second, and is seen in Plates I and XIV.

The 6th ray of the dorsal fin (121) is indicated in Plates I and XIV. In the latter plate it is exposed from the posterior side, while in Plate I it is still articulated and is in the natural position.

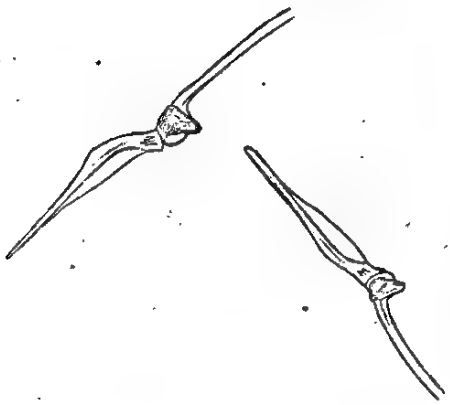

FIG. 5. Dorsal ray, interneural spine, anal ray, interhæmal spine, and cartilaginous nodules. The nodules are seen between the rays and spine. × 1.5.

The interhæmal spine (57) is in the posterior abdominal region. The first spine in this series is almost straight, with a condyle at its ventral extremity to articulate with the anal ray. In the others there is an anterior vertical fossa, while the posterior portion is lamellar. No. 117. This is illustrated in Plates I and XIV. Interhæmal spines (117). The 19th and 20th spines are indicated by this number in Plates I and XIV, being situated in the posterior abdominal region.

Rays of the anal fin (58). This number in Plates I and XIV represents one of the anal rays from the posterior side, showing the two lateral portions and the cartilaginous nodule between their distal ends.

Interneural spines (82). The spines indicated by this number, 82, in Plates I and XIV are in the posterior abdominal region. In Plate XIV the dorsal rays in this region are not represented, but they are present in Plate I.

Anal ray (118). The 3d anal ray in Plates I and XIV bears this number.

The 24th anal ray is labeled 119 in Plates I and XIV.

Anal rays 4 to 11 are indicated by number 120 in Plates I and XIV. Those in Plate XIV are viewed from the posterior

side, except the 5th, which presents the left side and shows no cartilaginous nodule. They lie opposite the corresponding interhæmal spines.

VIII. BRANCHIAL APPARATUS

PLATES XV AND XVI

Basibranchials (17). These are clearly illustrated in Plates XV and XVI, in the former articulated, and in the latter disarticulated, but contiguous to those bones with which they are articulated.

The 1st is thickest at the posterior end, where it is not quite as thick as wide. A slight ridge extends from the anterior to the posterior end on the ventral side.

The 2d is seen from the dorsal side, but, as the bone is rather deep, a profile drawing from the left side is shown in text fig. 6.

The 3d is about two-thirds as thick as broad, and has fossæ at the articulations of the hypobranchials (24) of the second branchial arch and also at the posterior end.

The 4th basibranchial has a shaft posteriorly, becomes thinner, and just posterior to the middle widens out into 2 thin lateral flanges. Anteriorly, it is broadly wedge-shaped.

Hypobranchials (24) of the first arch. The outline of the hypobranchials of the first arch is shown in Plate XVI, except the epicondyle of the interior end. The dorsal portion of the interior end articulates with the lateral fossa of the 3d basibranchial (17). The epicondyle passes to the ventral side of the 3d basibranchial (17) and forward, articulating with the posterior ventral portion of the 2d basibranchial (17). The anterior process is almost lamellar. Laterally and distally these hypobranchials articulate with the ceratobranchial (63). The anterolateral margin is covered with small detachable plates of cardiform teeth (133) which take the place of gill rakers.

Hypobranchials of the 2d arch. These bones articulate distally with the ceratobranchials (63). Proximally the articulation is with the fossæ of the 4th basibranchial (17), the posteroventral margin of the 3d basibranchial, and with the anteroventral process of the hypobranchials of the 3d branchial arch. They are convex anterodorsally and concave posteroventrally. The ventral anterolateral epicondyle is lamellar. The anterolateral surface is covered with detachable plates of cardiform teeth.

Hypobranchials of the 3d arch. The outline is clearly seen in Plate XVI. Medially and posteriorly they articulate with

the ceratobranchials (63) of the 4th arch, the posterodorsal portion of the 4th basibranchial (17), and the hypobranchials of the 3d arch on the opposite side. Distally they articulate with the ceratobranchials (63) of the 3d arch. The anterior process articulates with the proximal ventral epicondyle of the hypobranchials of the 2d branchial arch and with the anterior process of the hypobranchials of the 3d arch on the opposite side.

Unlike other hypobranchials, those of the 3d arch have areas of cardiform teeth on the posterodorsal side which are firmly fixed and not detachable. Also, these areas are much larger than the detachable areas of the other hypobranchials and modified epibranchials (74) of the 1st branchial arch. There are no hypobranchials in the 4th branchial arch.

In Plate XV the hypobranchials are still articulated, and are shown from the dorsal side.

Upper or superior pharyngeals (23). These are designated by 23^2, 23^3, 23^4, referring to the different branchial arches, 23^2 articulates with the epibranchial (64) of the 2d arch, 23^3 articulates with the epibranchial (64) of the 3d arch, and 23^4 articulates with the epibranchial (64) of the 4th arch. In Plates XV and XVI the upper pharyngeals are shown moved outwardly and posteriorly, together with the epibranchials (64), on the articulation of the epibranchials and the ceratobranchials (63) as a hinge. In the latter plate they are not articulated, while they are in the former. In their natural position the upper pharyngeals lie dorsad of the inferior pharyngeals (25), so that their toothed surfaces lie together. The upper pharyngeals of the 2d and 3d arches and the epibranchials (64) of the 2d arch articulate with the ventral side of the basioccipital (69).

In some specimens examined, certain of the teeth of the superior pharyngeals of the 4th arch were seen to be growing from the sides of large sockets, presumably of larger, more mature teeth already shed.

Lower or inferior pharyngeals (25). These are articulated anteriorly and laterally with the ceratobranchials (63) of the 4th branchial arch, the posterodorsal portion lying interior to the ceratobranchials (63). As seen in Plate XVI, they are provided with teeth which increase in size posteriorly. They are very small anteriorly and very large posteriorly. Along the posterior margin small teeth are seen in large sockets—the same condition existing as is described in No. 23. Plate VI, fig. 1, and Plates XV and XVI illustrate these.

Ceratobranchials (63). These are concave below and convex above. The condyles or glenoid surfaces of the proximal ends are much larger than those of the distal ends. All are at least slightly concave. Those of the 1st, 2d, and 3d branchial arches articulate with the hypobranchials (24) proximally and distally with the epibranchials (74) of the 1st branchial arch and (64) of the 2d and 3d branchial arches. As there are no hypobranchials (24) of the 4th branchial arch, the ceratobranchials of this arch articulate proximally with the hypobranchials (24) of the 3d branchial arch, the 4th basibranchial, and the proximal end of the inferior pharyngeals (25). Distally the articulation is with the distal end of the epibranchials (64) of the 4th branchial arch. All of the ceratobranchials are covered, on the convex surface, with detachable patches of cardiform teeth, the same as are spoken of in the descriptions of the hypobranchials (24) and the epibranchials (74) of the 1st branchial arch. The margins of the concavity on the ventral side of each of the ceratobranchials are fringed with branchial lamellæ. (Plates XV and XVI.)

Epibranchials (74) of the first branchial arch. These bones form a part of the accessory branchial apparatus. Each consists of a dorsal vertical portion, about two-fifths of the total length, which articulates dorsally with the margin of the flat ventral portion of the pterotic (38), where the pterotic forms a part of the roof of the accessory branchial chamber. Continuous with the dorsal spinous portion and at the internal angle of the more ventral lamellar part is a thickening or reënforcement which becomes thicker at the ventral end where this epibranchial articulates with the ceratobranchial (63) of the first branchial arch. The lower portion is lamellar, with a broad internal more ventral part at an angle of about 60 degrees to an external lateral portion, which extends farther dorsally into the accessory branchial chamber. Ventrally the broad edge of the posterior portion and the narrow ventral part of the flange at an angle are continuous with the posterolateral end of the first ceratobranchial (63), helping to form the first branchial arch. The whole ventral margin and, also, the ventral part of the interior angle are provided with the detachable patches of cardiform teeth (133), as in the ceratobranchials (63) and the hypobranchials (24). In Plate VI, fig. 1, the right is seen from the outer side, in Plate XVI both are seen from the inner side, disarticulated, and in Plate XV the left is but indistinctly seen.

Epibranchials (64) of the 2d branchial arch. These artic-

ulate distally with the ceratobranchials (63) of the 2d branchial arch and with the ventrolateral region of the basioccipital (69) and the superior pharyngeals (23 [2]) of the 2d branchial arch internally and ventrally, respectively. Because of being

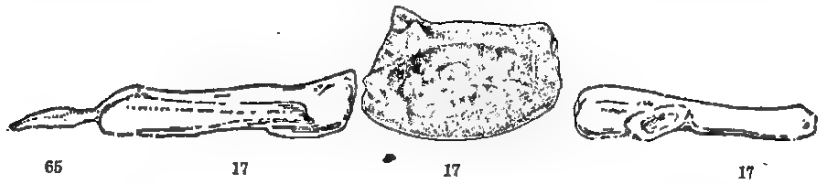

FIG. 6. Glossohyal (65); basibranchials (17) of the 1st, 2d, and 3 branchial arches from the left side; the basibranchial of the 2d arch in detail. × 2.

extended, the ventral instead of the dorsal surface is shown. The dorsal surface is concave, with the outside of the curve, the region of the epicondyle, lying anteriorly and dorsad of the ceratobranchials (63) and the anterior portion of the inferior pharyngeals (25). The proximal or internal condyle or that which articulates with the basioccipital (69) is much larger than that which articulates with the ceratobranchials (63) of the 2d branchial arch.

Epibranchials of the 3d branchial arch. These bones also are seen from the ventral side. The articulations distally are with the ceratobranchials of the 3d branchial arch and proximally with the superior pharyngeals (23 [3]) of the 3d arch. The two epicondyles shown at the top in Plate XVI lie dorsad in position against the anterior surface of the epibranchials of the 4th arch. The large condyle articulates with the dorsal surface of the superior pharyngeals (23 [4]) of the 4th branchial arch.

The epibranchials are seen in Plates XV and XVI.

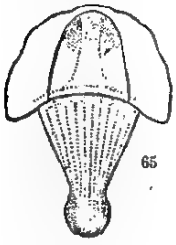

FIG. 7. Glossohyal (65), dorsal view, showing the more solid central portion. × 1.5.

Glossohyal (65). The more solid central portion of the glossohyal is shown articulated with the anterior end of the first basibranchial (17). The complete outline is shown in text fig. 7, the central, more solid portion being indicated. The glossohyal in small specimens is entirely cartilaginous, with the anterior and lateral margins much softer than the central portion. The drawing is the actual size of the glossohyal from a different fish from that of Plate XVI. In Plate XV the glossohyal has been removed. (Plate XVI.)

This number (133) in Plate VI, fig. 1, and in Plate XV in-

dicates detachable plates of cardiform teeth found on the branchial arches.

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NUMERICAL INDEX

57. Interhæmal spine.
58. Anal rays.
59. Ribs, Plate XII, ventral of double ribs.
60. Spine on lowest wide hypural.
61. Dorsal of double ribs, Plate XII.
62. Clavicle.
63. Ceratobranchials.
64. Epibranchials.
65. Glossohyal.
66. Parasphenoid.
67. Vomer.
68. Urohyal.
69. Basioccipital.
70. Atlas.
71. Mesopterygoid.
72. Exoccipital.
73. Otoliths.
74. Epibranchial modified of 1st branchial arch.
75. Supraethmoid.
76. Prefrontal.
77. Postclavicle, upper part.
78. Proötic.
79. Epiotic.
80. Pterygoid.
81. Ethmoid.
82. Interneural spines.
83. Basisphenoid.
84. Hypohyals.
85. Anterior dorsal radial.
86. Intra-articular.
87. Vertebra, the 2d, axis.
88. Vertebra, the 5th.
89. Vertebra, the 6th.
90. Vertebra, the 7th in Plate XI and No. 42 in Plate I.
91. Vertebra, the 20th.
92. Vertebra, the 21st.
93. Vertebra, the 22d.
94. Vertebra, the last but 7.
95. Vertebra, the last but 6.
96. Vertebra, the last but 5.
97. Centrum of vertebra, the 7th, bearing No. 90.
98. Centrum of vertebra, the 20th, bearing No. 91.
99. Centrum of vertebra, the 22d, bearing No. 93.
100. Centrum of vertebra, the last but 7, bearing No. 94.
101. Centrum of vertebra, the last but 5, bearing No. 96.
102. Hypural (?)
103. Hypural (?)
104. Upper double rib, the 13th.
105. Lower double rib, the 13th.
106. Upper double rib, the 14th.
107. Lower double rib, the 14th.
108. Upper double rib, the 15th.
109. Lower double rib, the 15th.
110. Rib, the 25th.
111. Rib, the 26th.
112. Rib, the 39th.
113. Rib, the 40th.
114. Rib, the 41st.
115. Anterior dorsal radial.
116. Second dorsal ray.
117. 19th and 20th interhæmal spines.
118. 3d anal ray.
119. 24th ray of anal fin.
120. Anal rays, 4th to 11th inclusive.
121. 6th ray of dorsal fin.
122. Alisphenoid.
123. Opisthotic.
124. Upper anterior part of hypural.
125. Neural spines of vertebræ bearing Nos. 92 and 95.
126. Neural arch of vertebræ bearing Nos. 87, 88, and 94.
127. Prezygapophyses.
128. Postzygapophyses.
129. Last vertebra but 4.
130. Last vertebra but 3.
131. Last vertebra but 2.
132. Last vertebra but 1.
133. Patches of cardiform teeth on branchial arches in Plate XVII.
134. Anterior ventral process.
135. Posterior ventral process.

ILLUSTRATIONS

Plates from photographs by Day and Martin; text figures from drawings by Espinosa. The species represented in all of the plates and the text figures is *Ophiocephalus striatus* Bloch.

PLATE I

The whole skeleton, articulated; from the left side.

PLATE Ia

Anterior part of skeleton, natural size.

PLATE Ib

Middle part of skeleton, natural size.

PLATE Ic

Posterior part of skeleton, actual size.

PLATE II

The top of the skull from the dorsal side.

16, nasal.
26, supratemporal.
27, posttemporal.
35, supraoccipital.
36, frontal.
37, parietal.
38, pterotic.
39, sphenotic.
67, vomer.
72, exoccipital.
73, otoliths.
75, supraethmoid.
76, prefrontal.
79, epiotic.
81, ethmoid.

PLATE III

A part of the disarticulated skull.

16, nasal, from dorsal side.
36, frontals, left from dorsal side and right from ventral.
37, parietals, left from dorsal side and right from ventral.
38, pterotics, left from dorsal side and right from ventral.
39, sphenotics, left from dorsal side and right from ventral.
66, parasphenoid, from the dorsal side.
67, vomer, from the dorsal side.
73, otoliths, left from the inside and right from the outside.
76, prefrontals, from the dorsal side.
78, prōtics, left from dorsal side and right from ventral.
81, ethmoid, from the dorsal side.
83, basisphenoid, from the dorsal side.
122, alisphenoid, right from the ventral side.

PLATE IV

FIG. 1. Posterior portion of disarticulated skull. The left side of the figure is anterior.

35, supraoccipital, from the dorsal side.
69, basioccipital, from the dorsal side.
72, exoccipitals, from the dorsal side.
79, epiotics, left from ventral side and right from dorsal.
123, opisthotics, left from ventral side and right from dorsal.

2. Top of skull from right side.

36, frontal.
38, pterotic.
39, sphenotic.
66, parasphenoid.
67, vomer.
69, basioccipital.
72, exoccipital.
76, prefrontal.
78, proötic.
79, epiotic.
83, basisphenoid.

PLATE V

FIG. 1. Ventral side of top of skull.

35, supraoccipital.
36, frontal.
38, pterotic.
39, sphenotic.
66, parasphenoid.
67, vomer.
69, basioccipital.
72, exoccipital.
76, prefrontal.
78, proötic.
79, epiotic.
83, basisphenoid.
122, alisphenoid.
123, opisthotic.

2. Posterior view of top of skull.

35, supraoccipital.
38, pterotic.
69, basioccipital.
72, exoccipital.
79, epiotic.
123, opisthotic.

PLATE VI

FIG. 1. Right side of skull with suspensorium and jaws removed.

1, premaxillary.
13, suboperculum.
14, operculum.
16, nasal.
22, branchiostegals.
25, lower or inferior pharyngeals.
26, supratemporal.
27, posttemporal.
36, frontal.
38, pterotic.
39, sphenotic.
40, interoperculum.
65, glossohyal.
66, parasphenoid.
67, vomer.
68, urohyal.
70, atlas.
72, exoccipital.
74, epibranchial, modified of 1st branchial arch.
76, prefrontal.
78, proötic.
84, hypohyal.
123, opisthotic.
133, patches of cardiform teeth.

2. Orbitals.

18^1 to 18^5, suborbitals; 18^5, of top row from the posterior side.
18^6, preorbital from outside.

PLATE VII

Suspensorium, opercles, and palatine. All the bones of the right side are seen from the outside. Those at the top—articulated—are from a smaller specimen than those below.

2, palatine.
7, quadrate.
8, metapterygoid.
9, symplectic.
10, hyomandibular.
11, preoperculum.
13, suboperculum.
14, operculum.
40, interoperculum.
71, mesopterygoid.
80, pterygoid.

PLATE VIII

Suspensorium, opercles, and palatine. The bones of the left side seen from the inside.

2, palatine.
7, quadrate.
8, metapterygoid.
9, symplectic.
10, hyomandibular.
11, preoperculum.
13, suboperculum.
14, operculum.
40, interoperculum.
71, mesopterygoid.
80, pterygoid.

PLATE IX

The mandible.

1, premaxillaries, left from dorsal and right from ventral side.
3, dentaries, left from dorsal and right from outer side.
4, articulars, left from dorsal and right from outer side.
5, maxillaries, left from dorsal and right from ventral side.
12, angular, right from outer side.
86, intra-articulars from dorsal side.

PLATE X

The girdles.

6, postclavicles; lower part, left from inside, right from outside.
15, hypercoracoid; left from inside, right from outside.
28, supraclavicles; left from inside, right from outside.
29, pectoral rays; left from inside, right from outside.
30, hypocoracoid; left from inside, right from outside.
31, actinosts; left from inside, right from outside.
32, pelvic girdle; from dorsal side.
33, pelvic rays; from dorsal side.
62, clavicles; left from inside, right from outside.
77, postclavicle; upper part, left from inside, right from outside.

PLATE XI

Anterior and median abdominal vertebræ.

43, neural spine.
46, transverse process.
47, transverse process.
49, transverse process.
70, atlas.
87, axis.
88, 5th vertebra.
89, 6th vertebra.
90, 7th vertebra.
91, 20th vertebra.
92, 21st vertebra.
93, 22d vertebra.
94, vertebra, the last but seven.
95, vertebra, the last but six.
96, vertebra, the last but five.
97, centrum of vertebra, the 7th bearing No. 90.
98, centrum of vertebra, the 20th bearing No. 91.
99, centrum of vertebra, the 22d bearing No. 93.
100, centrum of vertebra, the last but seven bearing No. 94.
101, centrum of vertebra, the last but five bearing No. 96.
126, neural arch of vertebra, bearing Nos. 87, 88, and 94.
127, prezygapophyses.
128, postzygapophyses.
134, anterior ventral process.
135, posterior ventral process.

PLATE XII

FIG. 1. Caudal vertebræ and hypurals.

34, hypural vertebra.
51, neural spine.
52, hæmal spine.
53, hypural.
60, anterodorsal spine of hypural.
102, hypural.
103, hypural.
124, upper anterior part of hypural.
129, last vertebra but four.
130, last vertebra but three.
131, last vertebra but two.
132, last vertebra but one.

2. Ribs.

59, ventral of double ribs.
61, dorsal of double ribs.
104, upper double rib; the 13th.
105, lower double rib; the 13th.
106, upper double rib; the 14th.
107, lower double rib; the 14th.
108, upper double rib; the 15th.
109, lower double rib; the 15th.
110, rib; the 25th.
111, rib; the 26th.
112, rib; the 39th.
113, rib; the 40th.
114, rib; the 41st.

PLATE XIII

Hyoid apparatus.

19, ceratohyals, from outside.
20, epihyals, from outside.
21, interhyals, from outside.
22, branchiostegals, from outside.
68, urohyal, from ventral side.
84, hypohyals, from outside.

PLATE XIV

Interneural spines and dorsal rays and interhæmal spines and anal rays.

44, interneural spine, anterior abdominal.
45, dorsal rays.
57, interhæmal spine.
58, anal rays.
82, interneural spines.
116, second dorsal ray, from left side.
117, 19th and 20th interhæmal spines.
118, 3d anal ray.
119, 24th ray of anal fin.
120, 4th to 11th anal rays.
121, 6th ray of dorsal fin, from posterior end.

PLATE XV

Branchial arches, articulated.

17, basibranchials.
19, ceratohyal.
20, epihyal.
21, interhyal.
22, branchiostegals.
23, upper or superior pharyngeals.
24, hypobranchials.
25, lower or inferior pharyngeals.
64, epibranchials.
74, epibranchials, modified of 1st branchial arch.
84, hypohyal.
133, patches of cardiform teeth on branchial arches.

PLATE XVI

Branchial arches, disarticulated.

17, basibranchials.
23, upper, or superior pharyngeals.
24, hypobranchials.
25, lower or inferior pharyngeals.
63, ceratobranchials.
64, epibranchials.
65, glossohyal, central, more solid portion.
74, epibranchial, modified of 1st branchial arch.

TEXT FIGURES

FIG. 1. Caudal vertebra, the last but 2 (131), anterior view.

2. Atlas (70); axis (87); 3d, 4th, and 5th vertebræ; interneural spines; dorsal rays; and anterior dorsal radials (85 and 115).

3. Hypohyals (84), ceratohyals (19), epihyals (20), and branchiostegal rays (22). "Teeth" are found on some of the rays.

4. Urohyal (68), anterior view.

5. Dorsal ray, interneural spine, and ray, interhæmal spine, and cartilaginous nodules. The nodules are seen between the rays and spines.

6. Glossohyal (65); basibranchials (17) of the 1st, 2d, and 3d branchial arches from the left side; the basibranchial of the 2d arch in detail.

7. Glossohyal (65), dorsal view, showing the more solid central portion.

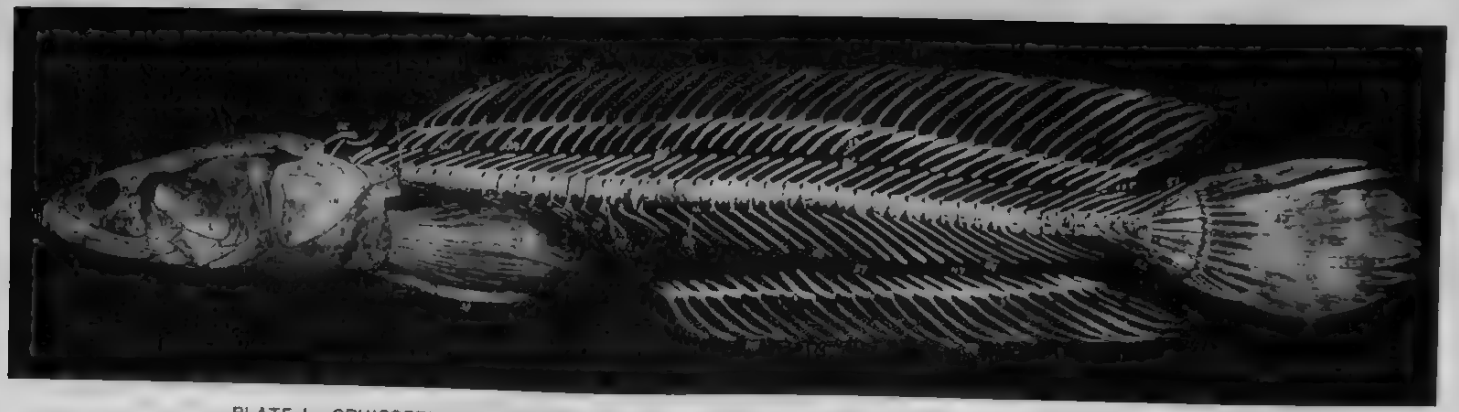

PLATE I. OPHIOCEPHALUS STRIATUS. THE WHOLE SKELETON, ARTICULATED, FROM THE LEFT SIDE.

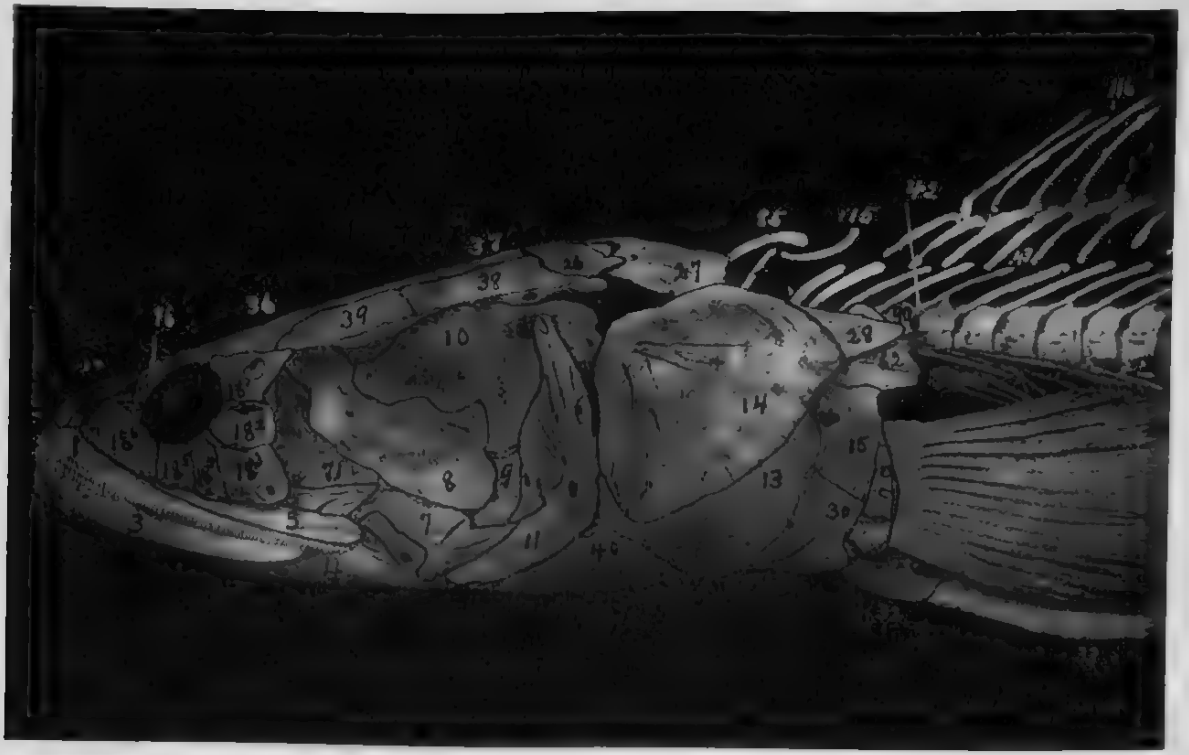

PLATE 1 A.

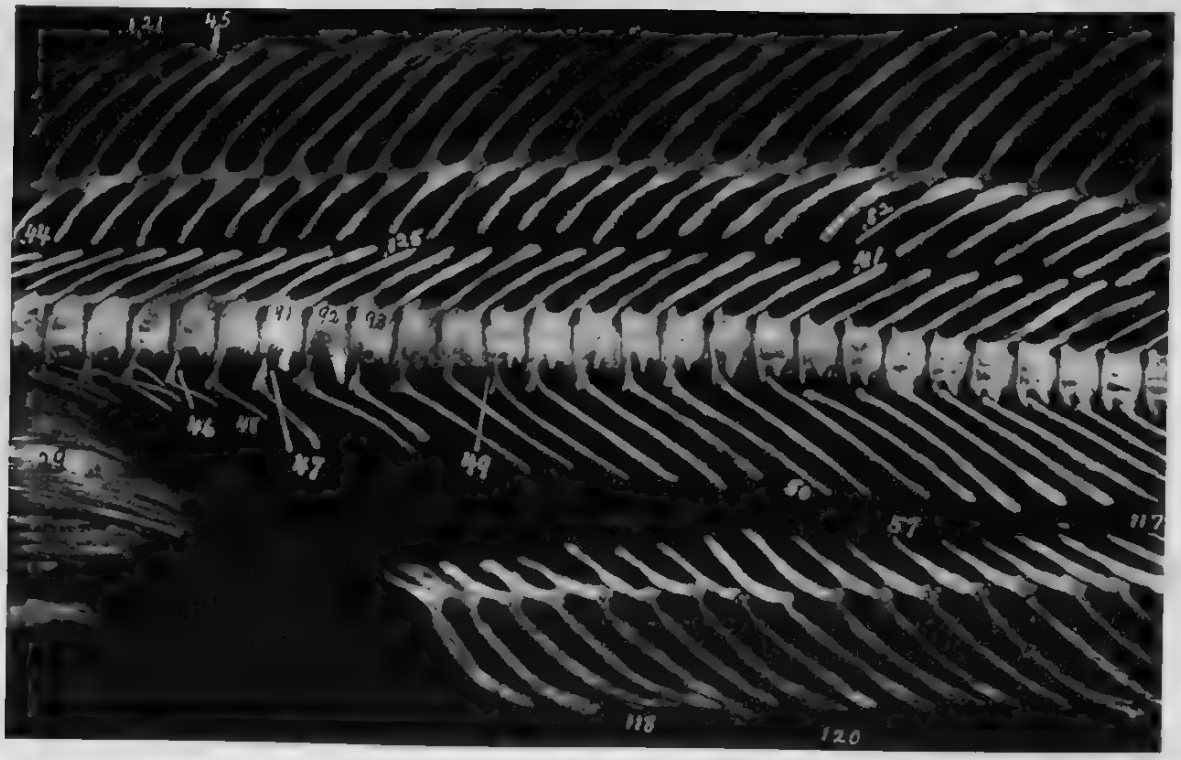

PLATE 18.

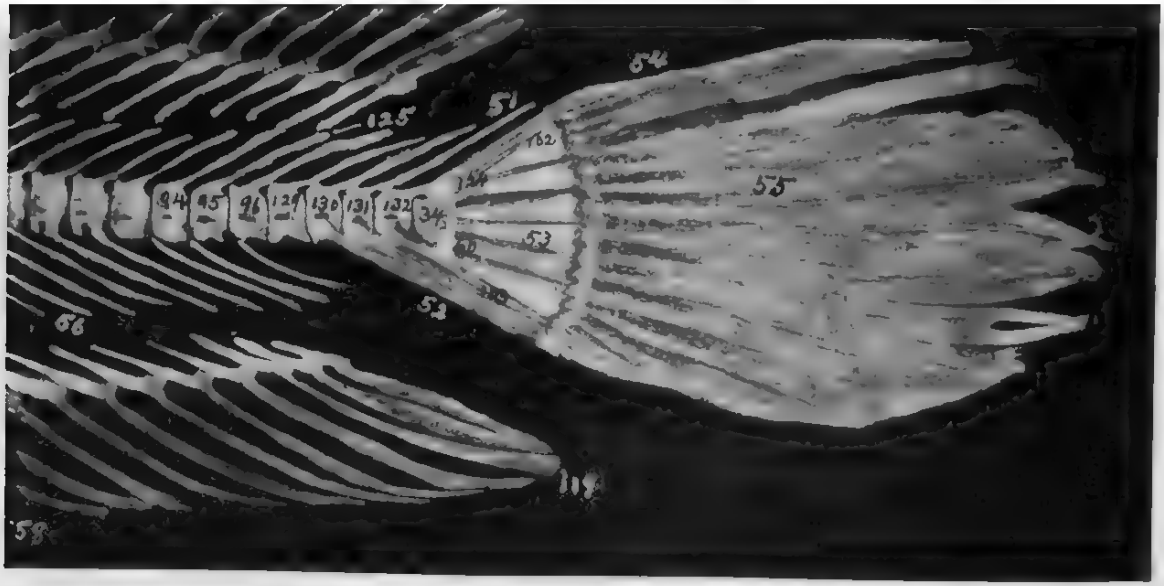

PLATE 1 C.

PLATE II. THE TOP OF THE SKULL FROM THE DORSAL SIDE.

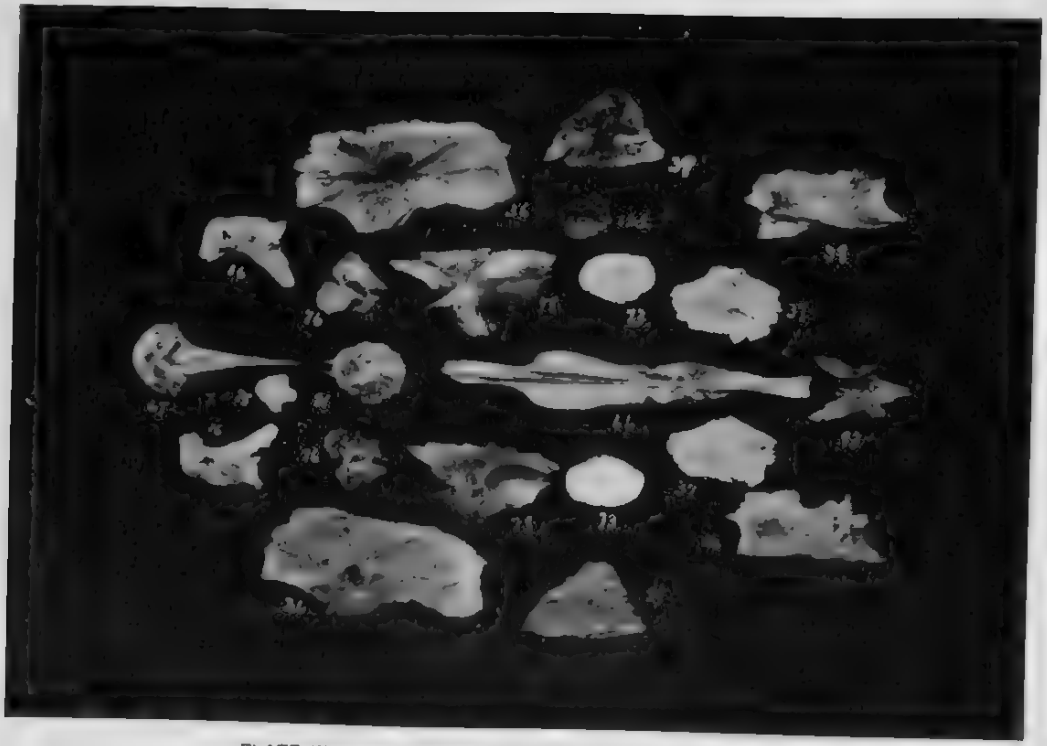

PLATE III. A PART OF THE DISARTICULATED SKULL.

Fig. 1. Posterior portion of disarticulated skull.

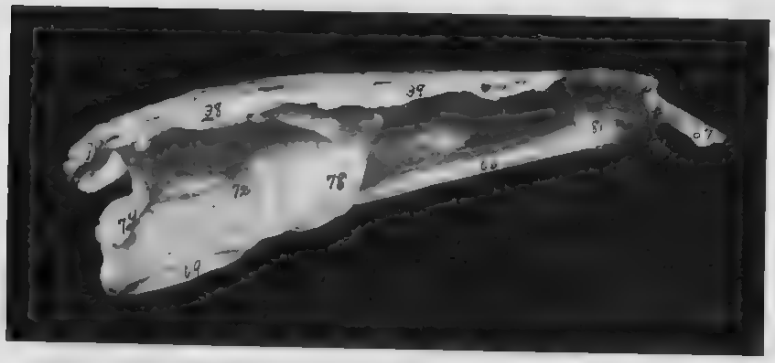

Fig. 2. Top of skull from the right side.

PLATE IV.

Fig. 1. Ventral side of top of skull.

Fig. 2. Posterior view of top of skull.

PLATE V.

Fig. 1. Right side of skull with suspensorium and jaws removed.

Fig. 2. Orbitals.

PLATE VI.

PLATE VII. SUSPENSORIUM, OPERCLES, AND PALATINE.

PLATE VIII. SUSPENSORIUM, OPERCLES, AND PALATINE.

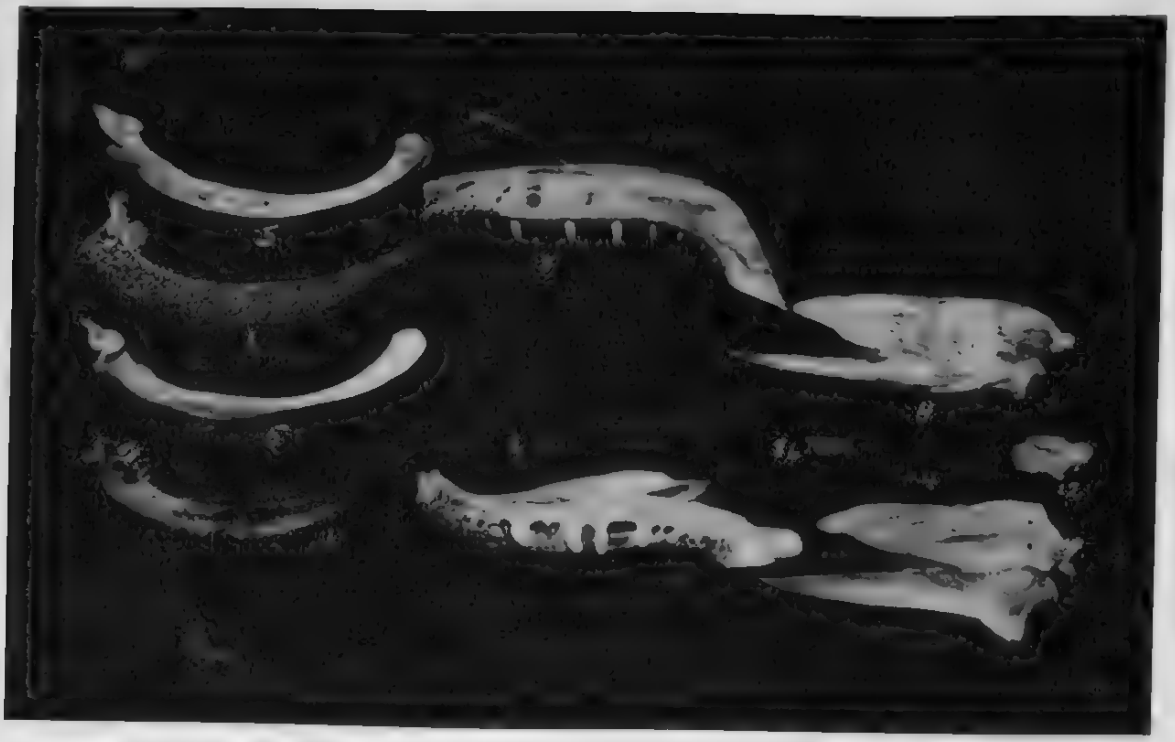

PLATE IX. THE MANDIBLE.

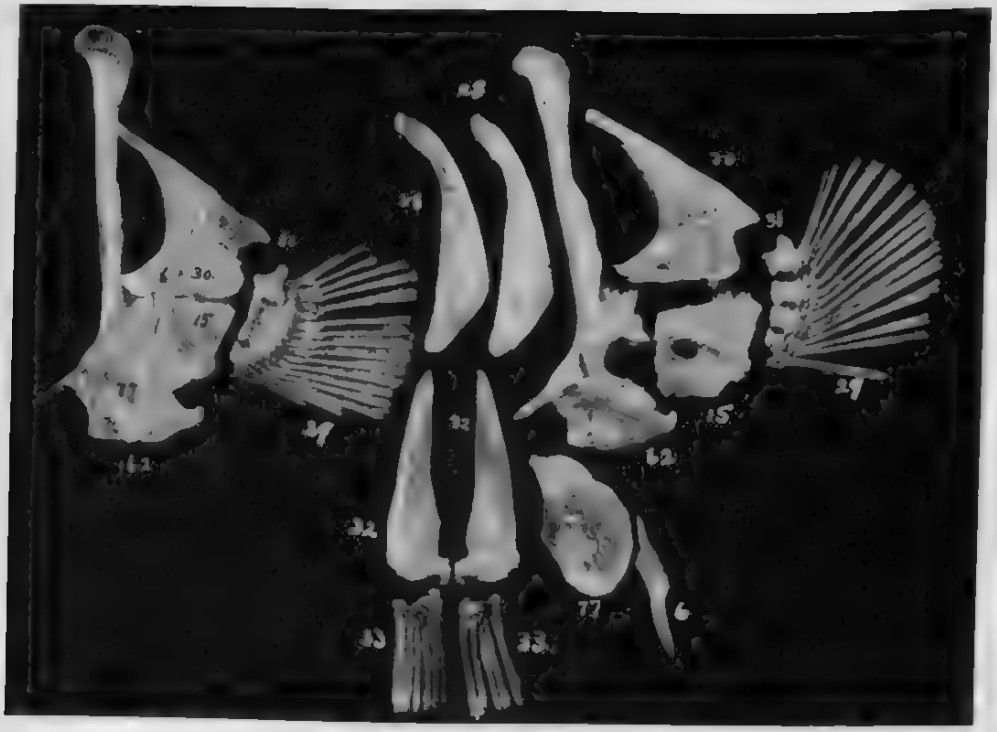

PLATE X. THE GIRDLES.

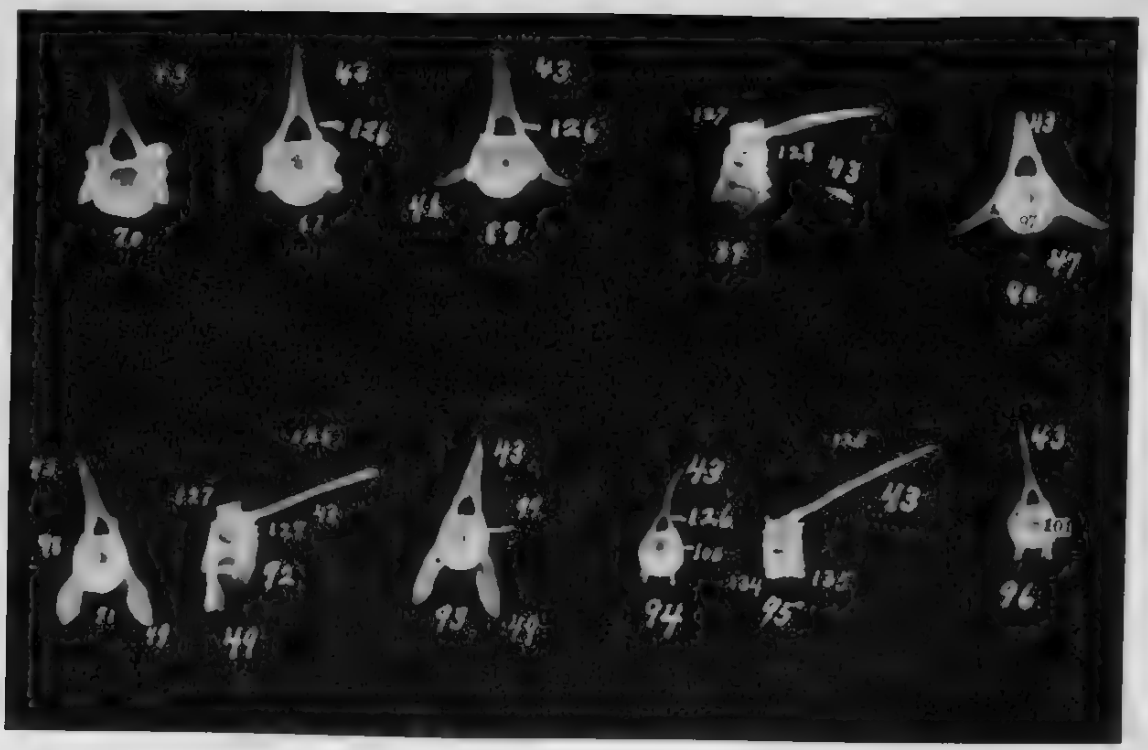

PLATE XI. ANTERIOR AND MEDIAN ABDOMINAL VERTEBRÆ.

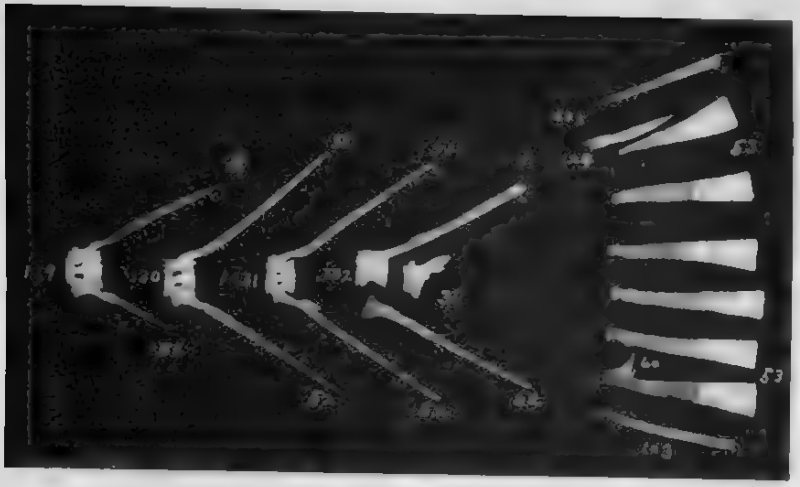

Fig. 1. Caudal vertebræ and hypurals.

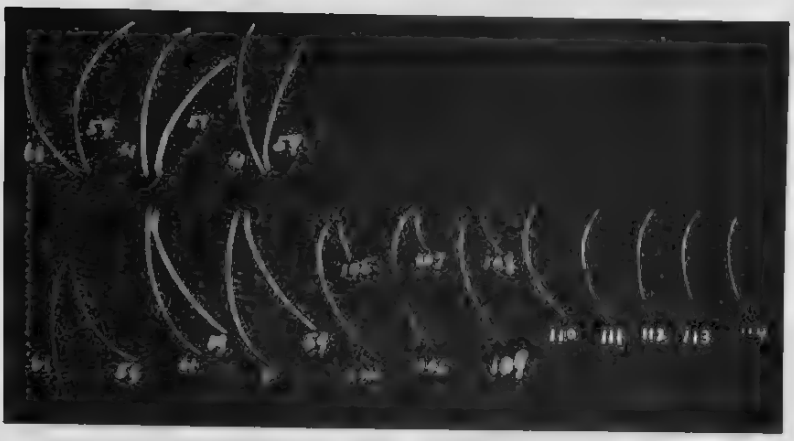

Fig. 2. Ribs.

PLATE XII.

PLATE XIII. HYOID APPARATUS.

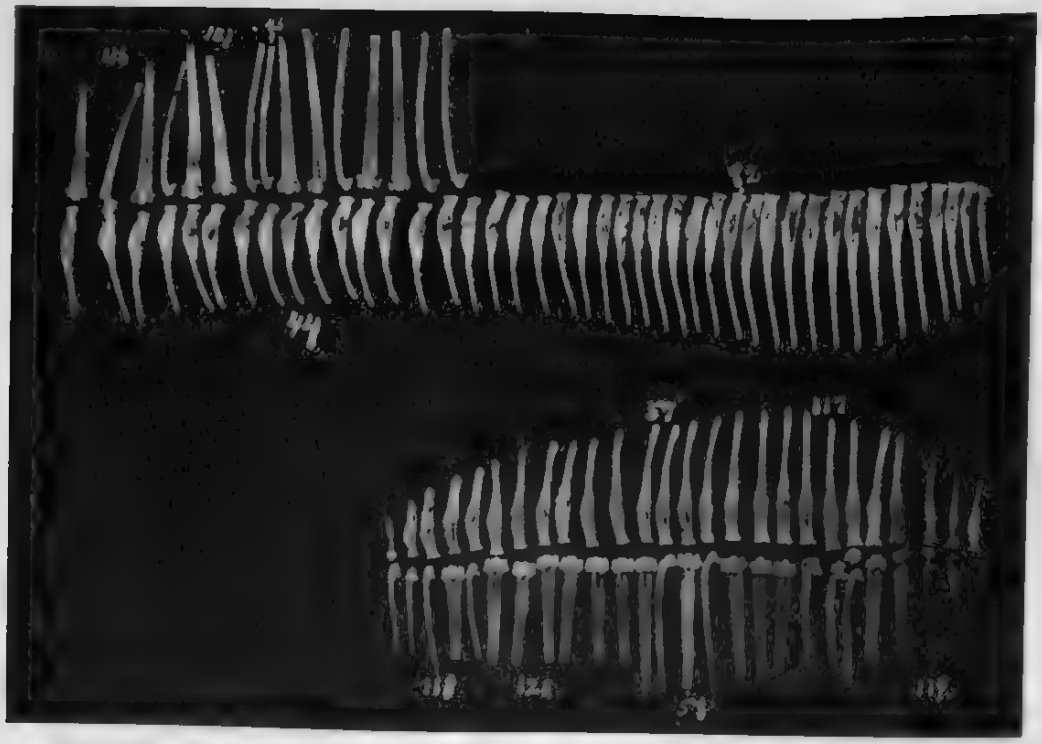

PLATE XIV. INTERNEURAL SPINES AND DORSAL RAYS AND INTERHÆMAL SPINES ANDANAL RAYS.

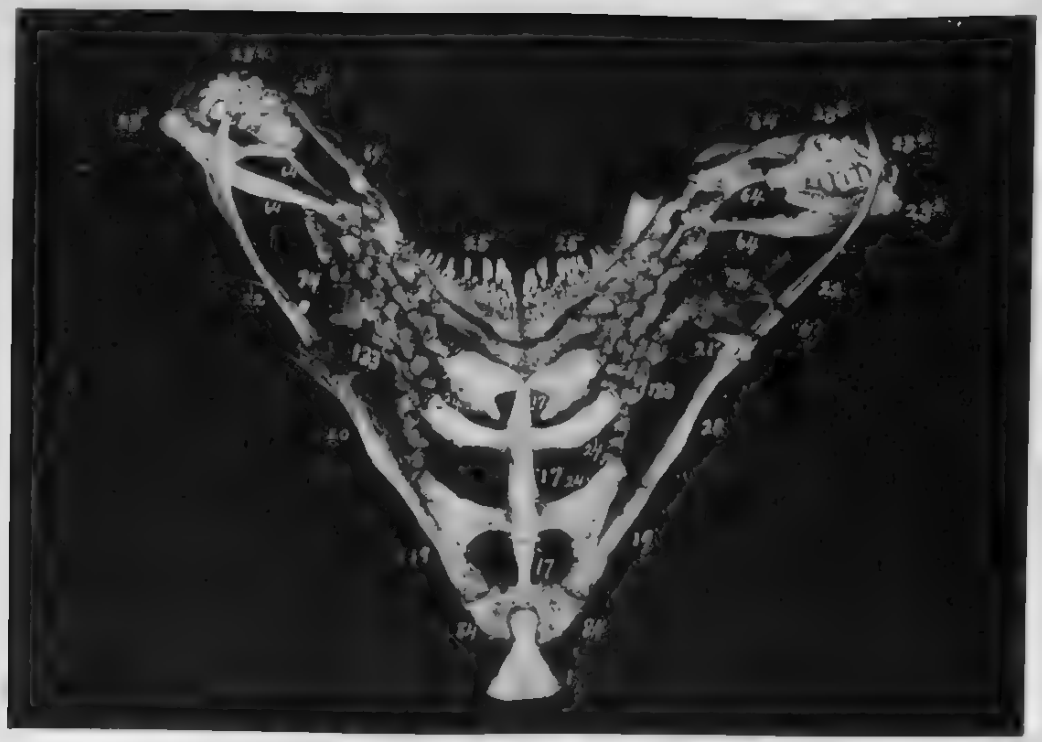

PLATE XV. BRANCHIAL ARCHES, ARTICULATED.

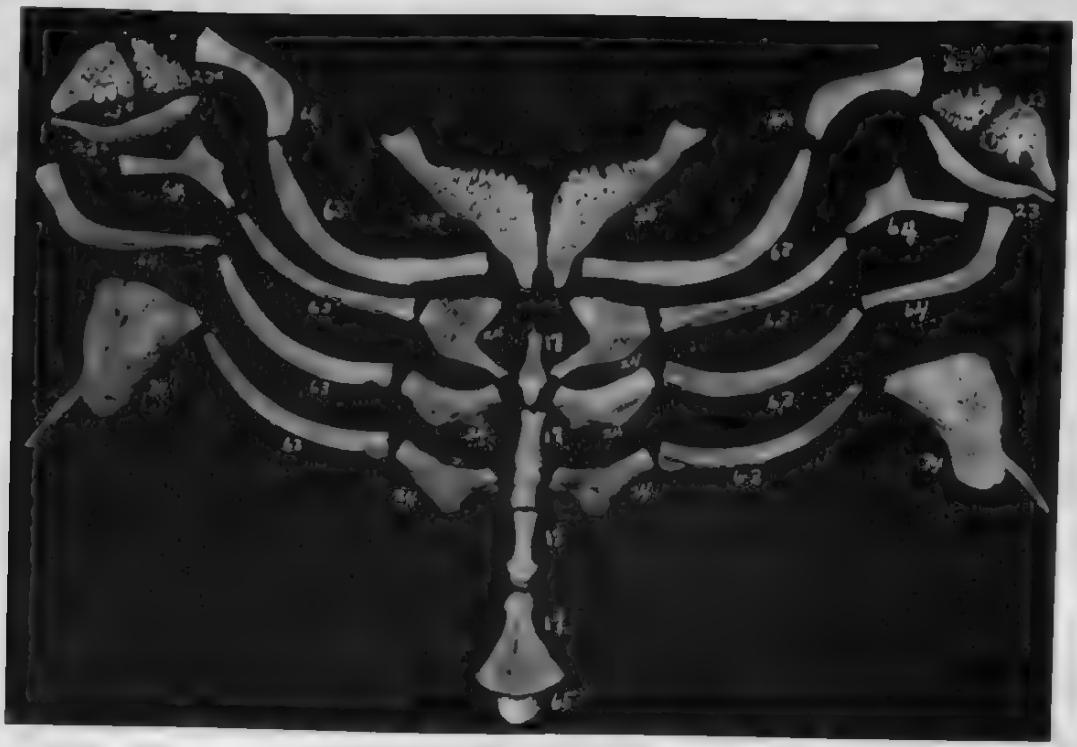

PLATE XVI. BRANCHIAL ARCHES, DISARTICULATED.

NOTE ON THE OCCURRENCE OF A FLYING CRUSTACEAN IN THE PHILIPPINE ISLANDS

By Dean C. Worcester

(*Manila, P. I.*)

While fishing along the base of a limestone cliff in Bacuit Bay, Palawan, during the month of December, 1912, I saw close to my launch what I at first mistook for a peculiarly formed flying fish of some species which I had never previously observed. It was translucent, rose from the water somewhat sharply, and "flew" not more than two or three rods before dropping into the water again.

The more I pondered on what I had seen the more it seemed to me that the creature could not be a fish. It had looked more like a crayfish or shrimp, with one or two pairs of much flattened legs directed forward and others curving backward, the legs and the lobes of the tail making the supporting planes.

On the evening of August 15, 1913, when trolling off the edge of the shoal extending in a southeasterly direction from East Island near the coast of Palawan, I again saw the same sort of a creature, and this time there was no mistaking it. It rose close to the boat, mounted into the air rapidly, then held a level course for a short distance, and dropped suddenly into the water again. It was unquestionably a very transparent crustacean, from 15 to 20 centimeters in length.

On the morning of August 17, when trolling off the shoal on the north side of Lumbucan Island, I saw a third specimen, and later in Malampaya Sound I saw a fourth. At this place Mr. W. Schultze, of the Bureau of Science, also saw one, and there remains no doubt of the existence in the Philippines of a marine crustacean, from 15 to 25 centimeters in length, which has the power of rising rapidly from the water and "flying," after the fashion of a flying fish, for several rods.

The specimens observed by me invariably rose against the wind.

FISHES OF HONGKONG

By ALVIN SEALE

(From the Section of Ichthyology, Biological Laboratory, Bureau of Science, Manila, P. I.)

Two plates

The following notes are based on a collection of fishes secured by me from the markets in Hongkong during the month of August, 1910. The native names of the fishes are copied from the Hongkong Official Market Report of April 28, 1910. With but few exceptions the species here listed are used as food by the people of Hongkong.

The measurements given are: 1, length of head in length of fish without caudal; 2, greatest depth in length to last caudal vertebra; 3, length of head, exclusive of opercular flap, in length of fish without caudal. The scale count is from head to last caudal vertebra; total length is taken from tip of snout to tip of caudal fin. The numerals given at the end of each description are the numbers of the specimens in the collection of the Bureau of Science, Manila.

ENGRAULIDÆ. (Anchovies)

Anchovia dussumieri Cuv. and Val.

This species is characterized by the elongate posterior extension of the maxillary which ends on a line with the anterior third of the ventral fins. (6398.)

Anchovia indica (Van Hasselt).

Engraulis russelli GÜNTHER.

Dorsal, 15; anal, 19; length, 5.5 to end of vertebra; 3 or 4 elongate spines on belly in front of ventrals. (6393, 6394, 6397, 6399, 6400, 6401, 6402, 6403, 6404, 6405, 6407.)

SYNODONTIDÆ. (Lizard fishes)

Trachinocephalus myops (Forster).

One specimen. (6595.)

Synodus japonicus (Houttuyn).

(6573, 6590, 6592, 6615, 6653, 6665.)

CYPRINIDÆ. (Carp, li yu)

Cyprinus carpio (Linn.).

Six specimens of the common carp were secured. This fish is extensively cultivated in Canton and brought alive to the Hongkong markets where it is kept in large fresh-water tanks. The Chinese seem to be very fond of the soft flesh of this species (6472, 6538, 6539, 6540, 6542, 6547).

SILURIDÆ. (Catfishes, chik yu)

Arius falcarius Richardson.

Three specimens; length, 150 to 160 millimeters. (6587, 6627, 6659.)

PLOTOSIDÆ. (Naked catfishes)

Plotosus arab (Forskål).

Seven specimens. Color brown with 2 longitudinal white bands. Length, 50 to 200 millimeters. (6570, 6591, 6597, 6617, 6619, 6628, 6825.)

BELONIDÆ. (Gar fishes, fa paw poong)

Tylosurus caudimaculatus (Cuvier).

Head, 2.90 to end of caudal vertebra; snout, 4.30; eye slightly less than the interorbital space; dorsal, 14; anal, 17. (6475.)

EXOCŒTIDÆ. (Flying fishes)

Cypsilurus simus (Cuv. and Val.).

Dorsal, 12; anal, 8; ventrals reaching middle of anal base; pectorals uniform dark blue, neither banded nor spotted. (6529, 6534, 6545.)

Hemiramphus cantoris Bleeker. (Halfbeak)

Head, 2.3 to end of caudal vertebra; snout beyond end of upper jaw, 2.25 in length; eye slightly less than interorbital space; dorsal, 15; anal, 14; upper lobe of caudal strongly tipped with black, lower lobe yellowish. Length, 195 to 225 millimeters. (6473, 6487, 6514, 6517, 6525, 6537.)

ATHERINIDÆ. (Silversides)

Atherina forskålii Rüppell.

Length, 51 to 60 millimeters. (7687, 7688.)

Atherina bleekeri Günther.

Length, 65 millimeters. (6406.)

MUGILIDÆ. (Mullets, chai yu)

Mugil longimanus Günther.

Scales, 32–12; dorsal, IV, 8; anal, III, 9. A dark spot in axil of pectorals; tip of caudal dusky; tip of soft dorsal dusky; maxillary completely hidden; adipose eyelid well developed; origin of dorsal over the anterior third of anal; pectorals equal to length of head; origin of spinous dorsal midway between end of caudal vertebra and origin of ventrals. (6270, 6273, 6274, 6276, 6278, 6279, 6282, 6283, 6284, 6286.)

Mugil cephalus Linn. (Striped mullet.)

Mugil oeur FORSKÅL.
Mugil macrolipidotus RICHARDSON.

Dorsal, IV, 8; anal, III, 8; scales, 38–40; head, 3.90; depth, 4; eye about equal to snout; a dusky stripe on center of each series of scales on upper half of body; a large dusky blotch on base of pectorals, adipose eyelid present and covering all of eye except pupil. Maxillary hidden except at tip. (6280, 6285.)

Mugil planiceps Cuv. and Val.

Greenish brown above, each series of scales with a darker line; pectorals short, equal to length from center of eye to posterior margin of opercles; adipose eyelid narrow, of greatest width posteriorly, scarcely covering half of iris; no spot in axil of pectorals; maxillary showing at tip. (6281.)

SPHYRÆNIDÆ. (Barracudas)

Sphyræna obtusata Cuv. and Val.

Head, 3; depth, 6; eye, 5.5; opercle ending in a single point. Length, 120 to 375 millimeters. (6452, 6492, 6496, 6498, 6507.)

Sphyræna jello Cuv. and Val. (Banded barracuda.)

One specimen, length, 175 millimeters. This species is characterized by the 16 dark bands over the back, the very small scales, and the 2 points on the opercle. (6448.)

POLYNEMIDÆ. (Threadfins)

Polydactylus tetradactylus Shaw.

Four pectoral appendages; tip of dorsal black; pectorals usually with a grayish wash. (6341, 6360, 6361, 6362, 6364.)

Polydactylus plebeius (Broussonet).

Young with 5 pectoral appendages, some of them of greater length than the pectorals; a black spot above origin of lateral line; tip of dorsals dusky; caudal lobes elongate, grayish at tip. (6368.)

FISTULARIIDÆ. (Cornet fishes)

Fistularia serrata Cuv.

Two specimens were secured, length, 320 and 410 millimeters, respectively; a young, probably of this species, has the scutes less developed, and is also characterized by some darker bars over the back. (6494, 6530.)

HOLOCENTRIDÆ. (Soldier fishes)

Holocentrus ruber Lacépède.

This beautiful species is very common in Hongkong. Length, 160 to 210 millimeters. (6395, 6396.)

SCOMBRIDÆ. (Mackerels, chi yu)

Scomberomorus guttatum (Bloch).

This is one of the best flavored fishes of the Hongkong market. Length, 223 millimeters. (7757.)

CARANGIDÆ. (Cavallas)

Trachurus trachurus Linn.

This species is characterized by the plates which extend the entire length of the lateral line; opercular spot, black. Length, 135 to 137 millimeters. (7759, 7765.)

Scomberoides lysan (Forskål).

Length, 130 millimeters. (7769.)

Caranx ophthalmotænia (Bleeker).

Length, 75 to 120 millimeters. (7760, 7766, 7770, 7771.)

Caranx malabaricus (Bloch and Sch.).

Length, 120 millimeters. (7764.)

Caranx boops Cuv. and Val.

Length, 80 to 90 millimeters. (7763, 7772.)

Caranx calla Cuv. and Val.

Length, 150 millimeters. (7762.)

Caranx djeddaba (Forskål).

Length, 200 millimeters. (7761.)

STROMATEIDÆ. (Butterfishes)

Stromateus niger Bloch. (Black pomfret, hak chong.)

The dorsal and anal rays are elongate and extend to a line with base of caudal; the ventrals extend to origin of anal. In specimens 10 centimeters in length, the ventrals and dorsal are considerably shorter and there is but a slight trace of a keel on the caudal peduncle. The very young are marked with indistinct dusky bands, and there is a dusky spot at the base of each lobe of caudal. (5405, 6289, 6291, 6299, 6315, 6317, 6318.)

Stromateus argenteus Bloch. (White pomfret, pak chong.)

Young.—No ventrals; no spines before dorsal or anal, the lobe of caudal not elongate, color white. (6311, 6312, 6320.)

EQUULIDÆ. (Slip mouths)

Equula insidiator (Bloch).

Length, 90 to 107 millimeters. Ten specimens. (6575, 6586, 6621, 6636, 6638, 6639, 6642, 6657, 6663, 6672.)

Equula ruconia (Hamilton-Buchanan).

One specimen, length, 56 millimeters. (6676.)

Leiognathus edwardsi Evermann and Seale.

Length, 60 to 170 millimeters. (6558, 6582, 6601, 6631, 6632, 6637, 6658, 6669, 6670.)

Leiognathus virgatus Fowler.

Length, 60 to 67 millimeters. (6551, 6584, 6645, 6655, 6673.)

Leiognathus daura (Cuvier).

Tip of snout and a portion of nape, dark. Length, 90 to 95 millimeters. (6565, 6599, 6662, 7394.)

APOGONICHTHYIDÆ. (Cardinal fishes)

Amia elizabethæ Jordan and Seale.

Length, 42 millimeters. (6335.)

Amia bifasciata (Rüppell). (Yang sun ko.)

Amia trimaculatus RICHARDSON.

Yellowish with a dusky vertical strip from the origin of spinous dorsal downward, another from the anterior portion of soft dorsal; a round spot at base of caudal; ventrals dusky; dorsal, caudal, and anal grayish. (6287, 6288, 6295, 6307, 6308.)

Amia marginatus Döderlein.

Color in alcohol yellowish; top of head and nuchal region with fine black specks; top of dorsals black, a black band through middle of soft dorsal; tips of anal and caudal dusky. (6290, 6294, 6302, 6348.)

Amia döderleini Jordan and Snyder.

Color in alcohol yellowish; a blackish stripe from snout through eye to the round distinct caudal spot; a dark line from above eye to near the upper margin of the caudal spot, another from subopercle to just below the caudal spot, another (frequently obliterated) on sides of belly, and another (often obliterated) along the base of the dorsal fins; a black line through bases of anal and soft dorsal; tips of caudal, soft dorsal, and anal grayish. (6266, 6292, 6298.)

Amia semilineatus (Schlegel).

Color in alcohol yellowish white; a jet black caudal spot; a black line from tip of snout through eye to posterior margin of opercle, another from snout over interorbital space to below origin of soft dorsal, and a third on median line of nuchal region; tip of spinous dorsal black. (6304.)

Amia lineatus (Schlegel).

Color in alcohol yellowish white, with a silvery wash on sides; about 11 or 12 vertical dark bars on each side, scarcely as wide as interspaces; tip of spinous dorsal and tip of caudal grayish. (6345, 6353.)

Amia kiensis Jordan and Snyder.

This is undoubtedly the species discovered and figured by Jordan and Snyder, but I suspect that it is *A. frænata* of Valenciennes; it is most certainly the species figured by Day as *A. frænata.* All of our specimens are without the caudal spot, the dark line from tip of snout extends to tip of caudal, the second dusky line is from tip of snout above eye to upper margin of caudal peduncle; the most persistent marking in all ages is the dusky tip to ventrals which is present in all specimens. There is a dark line through base of anal and soft dorsal. (6296, 6297, 6300, 6301, 6310, 6325, 6327, 6328, 6329, 6333, 6334, 6336, 6338, 6339, 6340, 6343, 6351, 6354, 6357, 6359.)

AMBASSIDÆ. (Wharf fishes)

Priopis urotænia (Bleeker).

Color yellowish white; a silver stripe from head to caudal; membrane between 2d and 3d dorsal spines dusky; 2 rows of scales on cheeks. (6323, 6324, 6326, 6330, 6331, 6332, 6337, 6342, 6346, 6347, 6352, 6355, 6356.)

SERRANIDÆ. (Garoupa, sek pan)

Cephalopholis bœnack (Bloch).

One specimen, length, 180 millimeters. (7776.)

Epinephelus moara (Schlegel).

This species is characterized by the 7 bands of dark brown over the back, the 2 or 3 anterior ones extending forward on to the head. This fish is well figured by Jordan and Seale.[1] Fifteen specimens. (7712, 7722, 7724, 7725, 7780, 7781, 7790.)

Epinephelus septemfasciatus Thunb.

Thirteen specimens of this species were secured. Length, 60 to 210 millimeters. This species is characterized by the 8 black vertical bands over the body; there are some enlarged teeth at the angle of the preopercle. (7778, 7779, 7782, 7783, 7791–7799.)

Epinephelus boenack (Bloch).

One specimen, this fish resembles somewhat *E. septemfasciatus*, but it has less distinct bands on the sides and the preopercular angle is distinctly rounded, with the teeth scarcely enlarged at angle. Length, 120 millimeters. (1784.)

Epinephelus merra Bloch.

This is a food fish of considerable importance in Hongkong. One specimen, length, 176 millimeters. (7715.)

Epinephelus dermopterus (Temm. and Schleg.).

Head, 3; depth, 2.55; eye slightly less than interorbital, 5 in head; snout slightly longer than diameter of eye; maxillary extending to a line with anterior margin of pupil; posterior margin of preopercle almost straight, some enlarged teeth at angle.

Dorsal, XI, 21; anal, III, 10; about 135 rows of scales from head to end of caudal vertebra; caudal rounded, body covered

[1] *Proc. Davenport Acad. Sci.* (1905), 10, Pl. 5.

with minute ctenoid scales; teeth in 2 or more rows; 2 enlarged curved canines anteriorly.

Color uniform brown, fins all darker, being almost black posteriorly; length, 111 to 185 millimeters. (7756, 7757.)

Epinephelus gilberti Richardson.

Color yellowish brown, with round darker brown spots the size of pulpil, over body. Two specimens, length, 235 to 270 millimeters. (7795, 7797.)

LUTIANIDÆ. (Snapper, lap yu)

Lutianus annularis (Cuv. and Val.).

Lutianus erythropterus DAY.

This species is distinguished by the black stripe from snout to origin of dorsal; the black saddle over the caudal peduncle bordered anteriorly and posteriorly with white; dark lines on body; ventrals tipped with black. Six specimens, length, 75 to 120 millimeters. (7704, 7705, 7706, 7707, 7708, 7709.)

Lutianus monostigma (Cuv. and Val.).

One specimen, length, 104 millimeters. (7753.)

Lutianus erythropterus Bloch.

This species resembles *L. vitta*, but is without the dark line on sides. Length, 67 to 180 millimeters. (7732, 7748, 7749, 7752, 7754, 7755.)

Nemipterus japonicus (Bloch).

Length, 98 to 115 millimeters. (7750, 7751.)

Diploprion bifasciatum (Kuhl and Van Hasselt).

This species is characterized by the 2 broad black bands which are very distinct even in alcoholic specimens. Length, 185 to 190 millimeters. (7773, 7774.)

THERAPONIDÆ. (Grunts)

Scolopsis vosmeri Bleeker.

This species is easily distinguished by the silvery white saddle over the neck and the black spot in upper axil of pectorals. Length, 140 millimeters. (7726.)

Therapon cuvieri (Bleeker).

Six specimens, length, 105 to 127 millimeters. The dark stripes terminate at the caudal, the markings below the median line of the side are almost obliterated. (7728, 7730, 7731, 7734, 7736, 7737.)

Therapon theraps (Cuv. and Val.).

Four small specimens, length, 95 to 105 millimeters. A common food fish of Hongkong. (7727, 7729, 7733, 7735.)

Therapon jarbua (Forskål).

Length, 51 to 72 millimeters. (7679, 7680, 7681, 7682, 7683, 7684, 7685.)

HÆMULIDÆ

Pristapoma hasta Bloch.

Six young specimens (6562, 6671, 7689, 7690, 7691, 7692) have the bands over the back; length, 65 millimeters. In the large specimen (7697) these bands are broken up into black spots; length, 170 millimeters.

SPARIDÆ. (Porgies)

Lethrinus mahsenoides Ehrenberg.

All of these specimens show the round black spots below the lateral line above the middle of pectorals. Length, 100 to 120 millimeters. (7693, 7694, 7695, 7696.)

Sparus datnia (Hamilton).

A food fish of importance. Length, 100 to 115 millimeters. (7744, 7746, 7747.)

Sparus berda Forskål.

Length, 110 to 142 millimeters. (7738, 7739, 7740, 7741, 7742, 7743, 7745.)

GERRIDÆ. (Mojarras)

Xystæma punctatum (Cuv. and Val).

Length, 67 to 100 millimeters. (6564, 6572, 6667.)

MULLIDÆ. (Surmullets)

Upeneus diplurus Playfair.

Color-yellowish, with a slight brownish wash above. A yellow stripe from eye to below second dorsal, a second yellow stripe from upper lip through lower border of eye to below second dorsal; these give the appearance of a brown stripe to the area between the two yellow lines; a yellow saddle over free portion of tail, a brown stripe down sides of snout. In old specimens the first dorsal is clouded with brown and the second dorsal and the anal are indistinctly barred with pale brown; in young specimens the fin markings are indistinct. (6444, 6457, 6485, 6506, 6512, 6513.)

Upeneus bensasi (Temm. and Schleg.).

No yellow band on sides (in alcohol), the dorsal with dusky bands; teeth of vomer very distinct—those of the palatine in an interrupted band. (6429, 6442.)

Upeneoides sulphureus (Cuv. and Val.).

One specimen. (6244.)

Upeneoides moluccensis Bleeker.

Head, 3.75; depth, 3.5; eye, 3.75; snout, 2.60; interorbital, 3.50; depth of caudal peduncle, 2.75; scales, 34 to end of caudal vertebra; villiform teeth in jaws, vomer, and palatines; dorsal, VIII, 1, 8; anal, 1, 6. The palatine teeth form a continuous band on each side; the vomerine teeth consist of a minute patch on the head of the vomer, easily overlooked. Length of the spinous dorsal is 1.20 in the depth of the fish. Color in alcohol pale yellowish brown above, yellow below, a bright orange band from eye to caudal; spinous dorsal, soft dorsal, and upper lobe of caudal with about 4 cross bars; tip of spinous dorsal dusky. It is probable that *U. moluccensis* Bleeker will be found to be synonymous with *U. bensasi* Temminck and Schlegel as these specimens partake of the characters ascribed to each of these species, with a predominance of those ascribed to *U. moluccensis*. (6420, 6423, 6425, 6431, 6436, 6441, 6445, 6458, 6460, 6488, 6526.)

Upeneoides tragula (Richardson).

This fish is known to the Chinese as *yang tswan* or *yéung tsun*. It is a common food fish in the Hongkong market. The color is yellowish white with a dusky stripe along the middle of side from eye to caudal. The body is thickly dotted with small brownish spots. The caudal has 4 oblique dusky bars. The dorsal fins are marked with blackish. Length, 20 centimeters. (6440.)

SCIÆNIDÆ. (Croakers)

Sciæna diacanthus (Lacépède).

Corvina catalea RICHARDSON.

Dorsal, IX, I, 20; anal, II, 7; scales about 52 in lateral line. Color in alcohol grayish yellow, dark spots on back and sides, pectorals and anal dark, remaining fins spotted, caudal very acute; teeth of upper jaw rather large, teeth of lower jaw large, upper jaw overhanging. Length, 50 to 70 millimeters. (6344, 6358, 6426, 6428, 6491, 6516, 7710.)

Sciæna aneus Bloch.

Length, 60 to 125 millimeters. (6349, 6350, 6415, 6456, 6461, 6467, 6481, 6490, 6497, 6520, 6544, 6674.)

Sciænoides biauritus Cantor.

Length, 150 to 165 millimeters. (6421, 6476.)

SILLAGINIDÆ. (Whitings)

Sillago sihama (Forskål).

One specimen, length, 165 millimeters. (6480.)

Sillago maculata Quoy and Gaimard.

Two specimens, length, 141 to 165 centimeters. (6471, 6532.)

CEPOLIDÆ. (Bandfishes)

Acanthocepola krusensternii (Temm. and Schleg.).

A narrow dark margin on anal and posterior portion of dorsal. Length, 130 to 140 millimeters. (6550, 6583, 6596, 6661, 7387, 7389.)

CIRRHITIDÆ. (Sea goldfishes)

Cirrhitities aureus (Temm. and Schleg.).

When alive these fish were golden in color, but in alcohol 5 or more very indistinct dusky vertical bands are visible on the body. It is probable that *C. oxycephalus* of Bleeker and *C. aureus* Temminck and Schlegel are the some species. These specimens have teeth on vomer and palatine. One specimen has the first dorsal ray prolonged into a filament. (6585, 8654.)

LABRIDÆ. (Wrasse fishes, wong fa yu)

Duymæria flagellifera Cuv. and Val.

Duymæria aurigaria GÜNTHER, Cat. Fishes Brit. Mus. (1862), 4, 121.
Duymæria flagellifera JORDAN AND SNYDER, Proc. U. S. Nat. Mus. (1902), 24, 623.

This species exhibits a large variety of color patterns, and shows great diversity in the length of the dorsal filaments. All of our specimens show the black tip to opercle. (6563, 6567, 6569, 6600, 6609, 6641, 6651.)

Thalassoma lunare (Linn.).

Characterized by the longitudinal purple bar extending on to the 4th to 8th pectoral rays. (6610.)

Stethojulis kalosoma Bleeker.

Color dull yellowish, lighter below; a dark, white-margined stripe from slightly below eye to a line with origin of soft dorsal fin; each scale on the lower posterior portion of body with a round brown spot; no spot on caudal or dorsal. (6635.)

Halichœres dussumieri (Cuv. and Val.).

Julis exornatus RICHARDSON, Rep. Brit. Assoc. Adv. Sci. for 1845 (1846), 258.

Halichœres nigrescens BLEEKER.

(6568, 6578, 6584, 6605, 6614, 6647, 6652.)

Halichœres javanicus Bleeker.

Color in alcohol yellowish, with 6 irregular purplish bands over the back, these being made up of purplish spots; dorsal with yellowish rings; anal with yellowish rings, almost obliterated in one specimen and entirely faded out in another; head with yellowish violet specks; a blue spot behind orbit and in axil of pectorals. (6580, 6589, 6626.)

Halichœres pœcilopterus (Schlegel).

One specimen, length, 170 millimeters. (6648.)

Chœrops ommopterus Richardson.

Dorsal spines, 12; scales of lateral line, 30; color in alcohol dull greenish, almost all the scales on the side showing a short vertical blue mark; on the caudal peduncle the blue marks are longitudinal instead of vertical, these form about 5 blue stripes on each side of the caudal peduncle; a blue stripe from angle of mouth to margin of opercle; a blue circle on base of pectoral; a darker line from eye along sides of snout to upper jaw; some blue lines on upper opercle; a jet-black spot below the base of the last dorsal spines. No yellowish area behind this spot as in *C. schœnlieni* Bleeker. Anal fin with blue lines and spots; ventrals yellowish, with slight markings of blue; none of the fins elongate. Length, 22 centimeters. (6571.)

SCARICHTHYIDÆ. (Parrot fishes, kai kung yu)

Callyodon limbatus (Richardson).

(6555, 6556, 6557, 6558, 6559.)

Callyodon dubius Bennett.

Pseudoscarus æruginosa GÜNTHER.

Color in alcohol pale greenish brown, 3 white stripes on sides of belly; lips wide, 3 rows of scales on cheeks, the lowest row of 2 scales. (6603, 6611.)

EPHIPPIDÆ. (Indian spade fishes, ying kung)

Ephippus orbis (Bloch).

Color yellowish with round blackish spots, usually larger than eye. The young have a dark ocular band, with the addition of a second dusky band on the shoulders. (6303, 6306, 6316, 6322.)

DREPANIDÆ. (Spade fishes)

Drepane punctata (Gmelin). (Ke lung tsang.)

Drepana punctata GÜNTHER, Cat. Fishes Brit. Mus. (1860), 2, 62; RICHARDSON, Rep. Brit. Assoc. Adv. Sci. for 1845 (1846), 244.

One specimen. (6277.)

CHÆTODONTIDÆ. (Butterfly fishes)

Chætodon aureus Temm. and Schleg.

Ocular band about equal in width to eye and with a broad yellowish white area in front and back of eye; ventrals yellow; the brownish lines on the rows of scales are almost longitudinal, except on shoulders where they are decidedly oblique; the caudal has a terminal margin of white and a narrow black line at a short distance from the margin. To this species belong *C. collaris* Jordan and Fowler[1] and *C. aureus* Günther both of which are from Japan. Evidently Richardson suspected that *C. aureus* Temminck and Schlegel and *C. collaris* Bloch might be the same, for he says that, "they agree tolerably well," which makes it certain they did not agree fully; therefore, he was not warranted in uniting them.

Chætodon reticulatus Cuvier and Valenciennes is quite distinct from both *C. aureus* Temminck and Schlegel and *C. collaris* Bloch, and is characterized by the broad black ocular band, which in most of its length is of much greater width than the eye; the lower portion of the ocular band extends backward to the origin of the ventrals and covers a large part of the thorax; the ventrals are yellow; the caudal has a very narrow margin of white with 2 black intermarginal lines separated by a yellow band; the base of caudal is jet black. *Chætodon prætextatus* Cantor seems to be a valid species most nearly related to *C. collaris* of Bloch, being characterized by the dusky ventrals, wide ocular band, and black tip to the opercles; Günther, who has specimens of both *C. prætextatus* and *C. collaris*, regards them as being different.

[1] *Proc. U. S. Nat. Mus.* (1902), 25, 534.

Chætodon collaris Bloch.

Chætodon collaris DAY, Fishes of India, Atlas (1878), Pl. 27, fig. 6; BLEEKER, Atlas Ichth. (1877), 9, Pl. 23, fig. 2; GÜNTHER, Cat. Fishes Brit. Mus. (1860), 2, 21; JORDAN and EVERMANN, Proc. U. S. Nat. Mus. (1903), 25, 356.

This species, which is without doubt *C. collaris* of Day, of Bleeker, and of Günther, is characterized by the dark ventrals, comparative narrow ocular band which does not extend to the origin of the ventrals, and the color of caudal which is broadly margined with white with a broad black bar near its center. *Chætodon collaris* Günther [3] is possibly a variety of *C. reticulatus* Cuvier and Valenciennes with the black ocular band extending backward on the thorax to the origin of the ventrals; it certainly has but slight resemblance to Bloch's type of *C. collaris*. The species described by Jordan and Evermann [4] is probably distinct and should be described as such.

Chætodon modestus Temm. and Schleg.

Chætodon desmotes JORDAN AND FOWLER, Proc. U. S. Nat. Mus. (1902), 25, 539.

This species is related to *C. rafflesii* Bennett which is, however, probably a valid species. (6293.)

Chætodon bella-maris Seale, sp. nov. Plate I, fig. 1.

Head, 3.10 in length without caudal; depth, 1.45; eye, 3.15 in head; snout slightly greater than diameter of eye; interorbital space slightly greater than snout; dorsal, XII, 23; anal, III, 21; lateral line strongly curved, ending at axil of soft dorsal, pores 46; scales in 34 series between head and end of caudal vertebra, 23 in a vertical series; head covered with fine scales; mouth small; teeth setiform; gill rakers low and pointed, about 17 on lower arch; spinous dorsal fitting into a scaled sheath at base, the 4th, 5th, and 6th spines the longest; soft dorsal rounded, no rays prolonged, length of longest ray but slightly less than head; caudal 1.35 in head, its margin almost straight; anal similar to soft dorsal; ventrals equal to length of head without opercular flap; a large axillary scale; pectorals equal to head with opercular flap.

Color in life yellowish, a black ocular band which is slightly greater than width of eye above the eye and slightly less than width of eye below; this band is continuous above, and extends to margin of subopercular below the eye; the band is margined

[3] Günther, Fische der Südsee (1873–75), Heft II, Taf. 31 A.
[4] Jordan and Evermann, *Proc. U. S. Nat. Mus.* (1903), 25, 356.

anteriorly and posteriorly with white; snout yellow; the tip of upper jaw black; a large black wedge-shaped mark on shoulder from spinous dorsal to the white border of the ocular band; this black area has a narrow prong of black extending from its posterior margin to upper tip of opercle; a narrow black margin to dorsal; a wide submarginal black band on posterior half of caudal; tip of caudal white; 12 to 14 rather wide, indistinct, brownish lines extending obliquely forward and downward on rows of scales; anal yellowish, with a marginal brown band; ventrals and pectorals yellowish.

This species is related to *C. lunula* Lacépède (*C. fasciatus* Bleeker), but differs in lacking the second black area on the shoulders and the semilunar band of black on soft dorsal, our specimen being without any black on the caudal peduncle, which according to Günther is present in *C. lunula* at all ages.

Type is No. 6321, Bureau of Science collection, collected in the Hongkong market by Seale, 1910.

Microcanthus strigatus (Cuv. and Val.).

Microcanthus strigatus CUV. AND VAL., Hist. Pcis. (1831), 7, 25, Pl. 120; GÜNTHER, Cat. Fishes Brit. Mus. (1880), 11, 34; JORDAN AND FOWLER, Proc. U. S. Nat. Mus. (1902), 25, 541.

Color in alcohol yellowish with about 5 or 6 longitudinal, slightly inclined, brown stripes, about the width of the eye. Spinous dorsal blackish, stripes on body projected into anal fin, ventrals with dusky tip; pectorals and caudal yellowish. (6313.)

SIGANIDÆ. (Siganids)

Siganus oramin (Bloch and Schn.).

Scattered white spots over body, caudal indistinctly barred, upper margin of eye serrated; a distinct shoulder spot. Length, from 80 to 205 millimeters. (6417, 6442, 6446, 6451, 6482, 6483, 6518, 6574, 6604, 6606, 6613, 6618, 6620, 6622, 7392.)

MONACANTHIDÆ. (File fishes, hih pe yang)

Monacanthus chinensis (Bloch).

Monacanthus chinensis GÜNTHER, Cat. Fishes Brit. Mus. (1870), 8, 236; RICHARDSON, Rep. Brit. Assoc. Adv. Sci. for 1845 (1846), 201. (6566, 6634.)

Monacanthus setifer Bennett.

Monacanthus setifer GÜNTHER, Cat. Fishes Brit. Mus. (1870), 8, 239; SCHLEGEL, Fauna Japonica (1842), 290, Pl. 130, fig. 1 (good).

Dorsal, 32; anal, 32. The second dorsal ray produced. Color in alcohol brown with obscure blackish spots or streaks.

Monacanthus lineolatus Richardson.

Color in alcohol dirty light brown with from 6 to 8 fine dark lines on the body from head to near caudal. A dark spot below anterior half of soft dorsal, a dark blotch on opercles, margin of ventral membrane black, caudal with 2 dusky bands. This species is well described by Richardson.[5] (6629.)

TETRAODONTIDÆ. (Puffers)

Spheroides spadiceus (Richardson).

This fish is believed to be poisonous. (6366, 6367, 6370, 6373, 6374, 6375, 6376, 6377, 6378, 6380, 6381, 6382, 6384, 6385.)

ELEOTRIDÆ.[6] (Eleotrids)

Bostrychus sinensis (Lacépède).

This species is very common in Hongkong. It is distinguished by the black ocellus on the upper base of the caudal rays. Length, 110 to 150 millimeters. (6414, 6424, 6427, 6450, 6465.)

Butis butis (Hamilton-Buchanan).

Length, 117 millimeters. (6433.)

Butis caperata Cantor.

Distinguished from *B. butis* by the shorter head, shorter snout, and larger eye. Length, 65 millimeters. (6495.)

GOBIIDÆ. (Gobies)

Boleophthalmus chinensis (Osbeck).

Gobius pectinirostris GMELIN.
Boleophthalmus boddaerti SCHLEGEL.

Length, 90 to 110 millimeters. (6410, 6413, 6454, 6466, 6468, 6469.)

Boleophthalmus glaucus Day.

Length, 67 millimeters. (6531.)

Rhinogobius hongkongensis Seale, sp. nov. Plate I, fig. 2.

Head, 4; depth, 5.60 without caudal; eye, 3.1 in head; snout equal to eye; interorbital space a narrow ridge; dorsal, VI, 12; anal, 11; scales 25 to end of vertebra, 8½ in a vertical series;

[5] Rep. Brit. Assoc. Adv. Sci. for 1845 (1846), 201.

[6] It seems advisable to advance the subfamily of Eleotrinæ to the position of a family characterized by the separate ventrals, and thus in part separating the cumbersome family Gobiidæ.

no scales on cheeks or opercles, nape fully scaled to posterior margin of eyes, 10 series anterior of spinous dorsal; snout rounded, jaws equal; maxillary extending to anterior margin of eye, teeth of lower jaw small, sharp pointed, in several rows—the outer row being enlarged curved teeth resembling canines; an extra large recurved canine on each side, upper jaw with a single series of strong sharp teeth; tongue truncated or but slightly rounded; gill openings wide, but not extending forward; body fully scaled, the scales on posterior half of body somewhat larger; no free silk-like rays at the origin of pectorals.

Spinous dorsal with the 2d, 3d, and 4th rays longest; soft dorsal and anal similar in form and of about equal height, their posterior rays being about 1.50 in head. The origin of soft dorsal is on a line with anal pore; origin of anal below the 2d dorsal ray; ventrals firmly united for entire length, the basal cup deep, length of the fin equal to distance from nostril to posterior margin of opercle; pectoral slightly greater than length of head; caudal rounded, 1.20 in head.

Color in alcohol pale wood brown with a series of about 14 small, more or less complete, circles of darker brown (sepia) along the median line of sides, margin of scales on upper half of body also slightly shaded with sepia, 1 or 2 narrow lighter longitudinal lines above the row of median circles; a black line from posterior margin of eye to upper base of pectoral fin, 4 or 5 blue spots on opercles and irregular brown blotch on cheeks below eye; 2 brownish blotches on base of pectoral; dorsals marked with about 4 longitudinal brownish lines; tip of spinous dorsal dusky; anal shading into slaty gray on outer third; caudal marked with whitish spots; pectorals and ventrals pale yellowish brown, the ventral with a slight grayish wash.

Three specimens from Hongkong market, August 9, 1910. Type is No. 6474, Bureau of Science collection; length, 70 centimeters; cotypes are Nos. 6489 and 6541.

Gobius pœcilichthys Jordan and Snyder.

Dorsal, VI, 10; scales about 35, upper pectoral rays silk-like; tongue truncate. Length, 57 to 60 millimeters. (6408, 6523.)

Glossogobius giuris (Hamilton-Buchanan).

Length, 74 to 78 millimeters. (6409, 6463, 6477, 6504.)

Oxyurichthus cristatus (Day).

Length, 85 millimeters. (6484.)

Oxyurichthus amabalis Seale, sp. nov. Plate II, fig. 1.

Head, 4 without caudal; depth, 6; eye, 4 in head; dorsal, VI, 13; anal, 14; scales, 50; enlarged scales on posterior half of body; 21 scales in vertical series; snout 3.30 in head; interorbital space a mere ridge; mouth large, the lower jaw slightly the longer; maxillary extending to below middle of eye; upper jaw with a single series of rather strong sharp teeth, lower jaw with a single row of similar but smaller teeth; tongue rounded; head naked except on the occiput which is finely scaled; no tentacles; about 24 scales in front of dorsal; anterior anal spine longest, 1.25 in head; soft dorsal and anal similar, origin of anal under 1st ray of soft dorsal; caudal long and acuminate, 2.60 in length of fish without caudal; ventrals scarcely equal to length of head, their origin is anterior to the origin of dorsal, their tip scarcely reaching to anal pore; length of pectorals, 3.5 in body without caudal; no silk-like rays.

Color a very light brown, white on chin and thorax, fins with a slight grayish wash, anal blackish.

Type is No. 6432, Bureau of Science collection, secured in Hongkong market by Seale; length, 130 millimeters; 3 cotypes, Nos. 6411, 6438, and 6453.

Gobiichthys tentacularis (Cuv. and Val.).

Length, 75 to 110 millimeters. 6500, 6501, 6505, 6510, 6515, 6519, 6523, 6524.)

Cryptocentrus filifer (Cuv. and Val.).

Length, 105 to 130 millimeters. (6412, 6430, 6447, 6449, 6470, 6478.)

Cryptocentrus venustus Seale, sp. nov. Plate II, fig. 2.

Head, 3.75; depth, 5.50; dorsal, VII, 10; anal, 11; scales on anterior portion of body very small, becoming larger posteriorly, about 90 in lateral series from posterior border of opercle to end of caudal vertebra, about 27 in a vertical series; mouth large, the maxillary ending slightly posterior to eye; teeth in several series, some slightly enlarged ones in the outer row of upper jaw and in the inner row of lower jaw, no recurved canines; no posterior canines; tongue truncate; gill rakers rather blunt, 14 on lower arch; head naked, without filaments or barbules; eye rather small, 4.5 in head, and about equal to length of snout; interorbital space very narrow, being equal to pupil; anterior dorsal rather high, its longest spine being equal to length of head, the 6th spine is located a considerable space from the 5th; origin of soft dorsal midway between end of caudal

vertebra and posterior margin of eye, the soft dorsal is similar to anal; caudal rather pointed, its length 3.25 in fish without caudal; origin of anal below 3d ray of soft dorsal; ventrals united and long, almost equal to caudal, the tip extending to anal pore, the cup at the base very deep; origin of ventral midway between tip of snout and origin of anal; pectoral slightly less than length of head, its base rather muscular.

Color in alcohol, a wide dark-brownish saddle over back at the spinous dorsal which extends downward on sides of belly; there is a similarly colored area above the anal fin along the middle of sides, remaining area lighter brown; a brownish area on head back of eyes and on cheeks, about 15 small scattered blue spots on cheeks; spinous dorsal, ventral, and anal dark purplish; soft dorsal dark with several lighter longitudinal lines, caudal and pectorals uniform brown.

One specimen, type No. 6419, Bureau of Science collection, from Hongkong; length, 103 centimeters. Collected by Seale and Canonizado.

Trypauchen vagina Bloch and Schn.

Color yellowish while. Length, 60 to 75 millimeters. (6493, 6527, 6543.)

Tridentiger bifasciatus Stindachner.

Outer row of teeth trifid, the middle cusp the longest, 2 black bands on sides, the one on middle of sides very wide and distinct, the other at base of dorsal much less distinct. Length, 40 to 55 millimeters. (6486, 6502, 6535, 6536, 6549.)

Apocryptes bato (Hamilton-Buchanan).

Dorsal, V-1, 13; anal, 14; length, 110 to 140 millimeters. (6418, 6439.)

SCORPÆNIDÆ. (Scorpion fishes)

Sebastopsis marmorata (Cuv. and Val.).

The dark bands over the back and spots on caudal, dorsal, and anal fins distinguish this species. Length, 100 to 130 millimeters. (7723, 7758.)

PLATYCEPHALIDÆ. (Flatheads)

Platycephalus insidiator (Forskål).

This fish is very common in the Hongkong markets. It is easily distinguished by the black and yellow stripe of the caudal fin. Length, 30 centimeters. (6593.)

Thysanophrys neglectus (Troch.).

This species is characterized by the spinate lateral line, the dusky spinous dorsal, and the dusky bars over back. (6559, 6623, 6630, 6664, 6675.)

Thysanophrys bataviensis (Bleeker).

Lateral line, 57; dorsal, caudal, pectorals, and ventrals with rows of black dots. (6656.)

CEPHALACANTHIDÆ. (Flying gurnards)

Cephalacanthus orientalis Cuv. and Val.

One young specimen, length, 65 centimeters. (6499.)

PLEURONECTIDÆ. (Plaice, pan us)

Pseudorhombus misakius Jordan and Starks.

Pseudorhombus misakius JORDAN AND STARKS, Proc. U. S. Nat. Mus. (1904), 31, 173.

Color light brown, mottled with darker brown; a black spot at branching of lateral line; dorsal, 80; anal, 63. (6579, 6581.)

Pseudorhombus russellii (Gray).

Yellowish, clouded with brown, some darker spots on back. Scales, 92; anal, 58; dorsal, 78. (6588.)

Pseudorhombus olegolepis Bleeker.

Two young specimens, scales 48. (6560, 6607.)

Tephritis sinensis (Lacépède).

Body with fine black spots, some of which are ocellated; fins, except pectorals and ventrals, marked with black. (6633.)

SOLEIDÆ. (Soles, yat sa yu)

Cynoglossus melanopterus Richardson.

Two lateral lines on left side, scales 60, fins dusky. (6577.)

Cynoglossus abbreviatus Gray.

Three lateral lines on left side, fins gray, lighter at tip, 120 scales in lateral line. (6646.)

Synaptura orientalis Bloch and Schneider.

Soles faleacea RICHARDSON.
Synaptura pan BLEEKER.

Brown with darker blotches and narrow black bands crossing the lateral line; posterior half of pectorals black. (6624.)

Solea ovata Richardson.

This seems to agree in all essential respects with Richardson's description. (6561.)

PTEROPSARIDÆ. (Pterosparids)

Parapercis pulchella (Temm. and Schleg.).

The figure of this species given by Temminck and Schlegel is excellent. It is a common species in Hongkong. Length, 160 millimeters. (6363–6371.)

Parapercis cylindrica (Bloch).

Body with narrow dark bands below and 5 wide bifurcated bands above; white and dark spots on throat and chin; a brown band from eye to throat, a dark spot at base of pectorals and on upper base of caudal; spinous dorsal black; soft dorsal and anal with yellowish spots; ventrals yellow. Length, 93 centimeters (6649); length, 82 centimeters (8503).

Percis sexfasciatus Temm. and Schleg.

Five bifurcated dusky bands over the back; a brown ocellus on the upper base of caudal; some dark dots at base of dorsal. Length, 85 millimeters. (6660.)

CALLIONYMIDÆ. (Dragonels)

Callionymus curvicornis Cuv. and Val.

I very much doubt if this species is synonymous with *C. valenciennesi* Schlegel, as in our specimen, as well as in the specimens Günther had from China, the preopercular spine is nearly as long as the orbit and is curved upward; it terminates in 4 hook-like processes, one of which is directed backward; a 5th process at the base of the spine points forward. The posterior of spinous dorsal, which is fin shaped, has a large black spot surrounded by white. The anal fin is white with dusky blotches near its tip. (6612.)

Callionymus hindsii Richardson.

This fish is characterized by the alternating vertical lines of jet black and pure white of the spinous dorsal, the black lines being somewhat crooked and of greater width in some places than in others. The preopercular spine ends in 4 recurved claws, with a fifth at the base of the spine directed forward. The anterior dorsal has 3 rays, the posterior has 10. In alcohol the fish is indistinctly speckled with very pale brown on the back, the caudal fin is indistinctly barred with brown and white; some indistinct light specks in soft dorsal, otherwise fins colorless, except the spinous dorsal. Length, 8.5 centimeters. (6650.)

ILLUSTRATIONS

(Drawings by T. Espinosa)

PLATE I

FIG. 1. *Chætodon bella-maris* Seale, sp. nov.
2. *Rhinogobius hongkongensis* Seale, sp. nov.

PLATE II

FIG. 1. *Oxyurichthus amabalis* Seale, sp. nov.
2. *Cryptocentrus venustus* Seale, sp. nov.

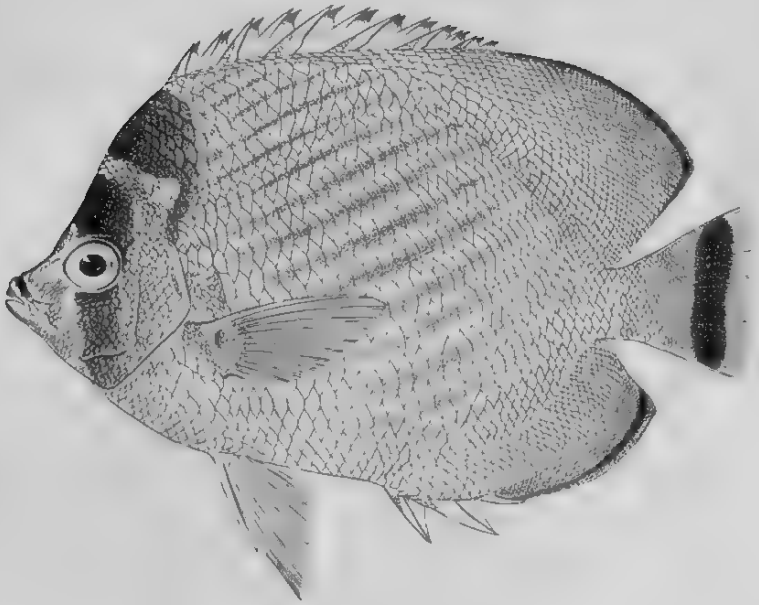

Fig. 1. Chætodon bella-maris Seale, sp. nov.

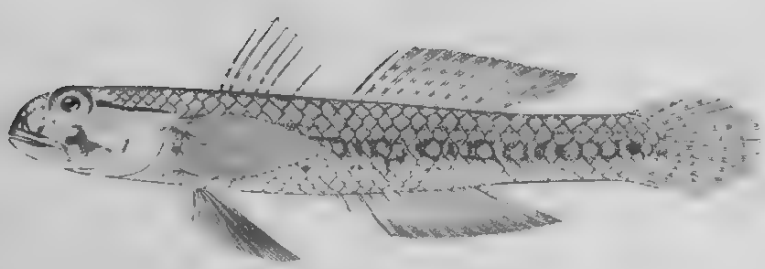

Fig. 2. Rhinogobius hongkongensis Seale, sp. nov.

PLATE I.

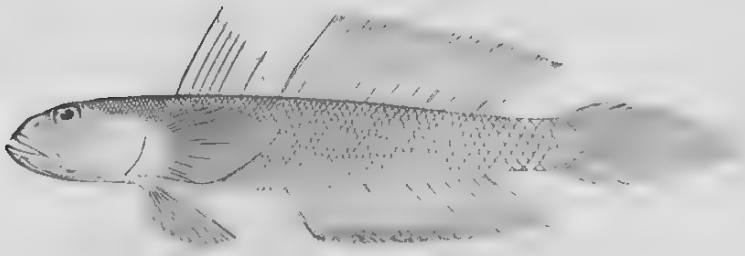

Fig. 1. Oxyurichthus amabalis Seale, sp. nov.

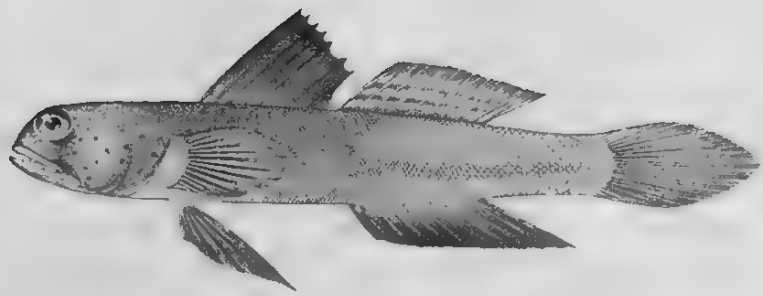

Fig. 2. Cryptocentrus venustus Seale, sp. nov.

PLATE II.

BUPRESTIDES RECUEILLIS AUX ÎLES PHILIPPINES PAR C. F. BAKER, I [1]

Par CH. KERREMANS
(*Brussels, Belgium*)

Une figure dans le texte

Acmaeodera luzonica Nonfr., Berl. Ent. Zeitschr. (1895), 40, 302.
LUZON, Los Baños.

Epidelus wallacei Thoms., Arch. Ent. (1857), 1, 109.
LUZON, Mt. Maquiling.

Chrysodema eximia Cast. et Gory, Monogr. Bupr. (1835), 1, 8, Pl. 2, fig. 9.
LUZON, Los Baños.

Chrysodema adjuncta Saund., Trans. Ent. Soc. London (1874), 310.
LUZON, Mt. Maquiling.

Dicercomorpha argenteoguttata Thoms., Typ. Bupr., App. (1879), 13.
LUZON, Los Baños.

Philanthaxia lata sp. nov.

Long. 8; larg. 3 mm. Oblong ovale, élargi au tiers postérieur, entièrement bronzé obscure, un peu mat, avec les angles postérieurs du pronotum d'un bronze plus clair, légèrement pourprés; dessous plus noir, pattes bronzées, tarses et antennes noirs, le 1er et le 2e article de celles-ci bronzés.

Tête plane; front vaguement déprimé; la surface couverte de points fins, confluents. Pronotum en trapèze, faiblement bisinué en avant et tronqué en arrière, les côtés obliques et à peine arqués, la surface couverte d'une ponctuation fine, très égale, semblable à celle de la tête, mais présentant sur le disque de fines rides sinueuses. Ecusson triangulaire, presque deux fois aussi large que long. Elytres légèrement élargis au tiers postérieur, finement dentelés sur les côtes de là jusqu'au sommet; celui-ci étroitement tronqué; la surface couverte de stries linéaires, plus rapprochées sur les côtés que sur le disque, les interstries aplanis, subrugueux, très également et densement ponctués. Dessous moins rugueux que le dessus, la ponctuation de l'abdomen aci-

[1] Proof read by C. F. Baker.

culée, et simulant de très fines écailles, couvert d'une pulvérulence blanche.

LUZON, Mt. Maquiling.

Chrysobothris bistripunctata H. Deyr., Ann. Soc. Ent. Belg. (1864), 8, 111.

LUZON, Los Baños.

Belionota fallaciosa H. Deyr., Ann. Soc. Ent. Belg. (1864), 8, 84.

LUZON, Mt. Maquiling.

Melibæus bakeri sp. nov.

Long. 4; larg. 1 mm. Petit, étroit, assez convexe, atténué en avant et en arrière, entièrement bronzé obscur et brillant, la partie antérieure du front verte.

Tête étroite, convexe avec une légère dépression longitudinale au dessus de l'épistome. Pronotum grand, convexe, faiblement bisinué en avant et en arrière; les côtés déprimés, la dépression prolongée le long de la base, la marge latérale arquée, anguleusement rentrante en arrière tout près de la base; la surface assez rugueuse, couverte de petites rides sinueuses et transversales. Ecusson petit, triangulaire. Elytres impressionnés de part et d'autre à la base avec le calus huméral saillant; les côtés sinués à hauteur des hanches postérieures, atténués en arc depuis le milieu, celui-ci séparément arrondi et inerme; la surface couverte de rugosités simulant de très fines écailles entre des rides sinueuses. Dessous moins rugueux que le dessus, mentonnière du prosternum bilobée.

LUZON, Los Baños.

Melibæus æneifrons H. Deyr., Ann. Soc. Ent. Belg. (1864), 8, 134.

LUZON, Mt. Maquiling; Los Baños.

Sambus auricolor Saund., Trans. Ent. Soc. London (1874), 322.

LUZON, Los Baños.

Sambus lugubris Saund., Trans. Ent. Soc. London (1874), 323.

LUZON, Mt. Maquiling; Los Baños.

Cryptodactylus philippinensis Saund., Trans. Ent. Soc. London (1874), 321.

LUZON, Los Baños.

Agrilus luzonicus sp. nov.

Long. 6.5–7; larg. 1.7 mm. Voisin de l'*A. acutus* Thunb., mais différent de celui-ci par une série de caractères constants. Toujours plus petit et moins ventru, l'impression médiane de la base

du pronotum moins profonde et moins large, l'épine terminale des élytres toujours moins longue et plus grêle, moins élargie à la base et montrant, sur le côté externe, une fine dentelure bien marquée, tandis qu'elle est moins nette et moins aiguë chez l'*acutus*, la coloration constante, d'un bronze verdâtre clair, rarement bleuâtre; enfin, l'aspect général plus lisse et plus brillant.

LUZON, Los Baños.

Agrilus nigrocinctus Saund., Trans. Ent. Soc. London (1874), 325.
LUZON, Los Baños.

Agrilus discicollis H. Deyr., Ann. Soc. Ent. Belg. (1864), 8, 189.
LUZON, Los Baños.

Agrilus vilis Saund., Trans. Ent. Soc. London (1874), 327.
LUZON, Los Baños.

Agrilus bakeri sp. nov.

Long. 8–8.5; larg. 2 mm. Allongé, légèrement élargi au tiers postérieur, atténué en arrière, tête, côtés du pronotum et extrémité des élytres cuivreux pourpré ainsi que le dessous, le pronotum et les élytres bleu verdâtre, ceux-ci ornés de part et d'autre de deux taches pubescentes et blanches, l'une au milieu, l'autre vers le tiers postérieur; le dessous couvert d'une pulvérulence blanche.

Tête forte, de la largeur du pronotum, sillonnée sur toute sa longueur, et couverte de rides sinueuses bien marquées. Pronotum un peu plus large que long et aussi large en avant qu'en arrière, faiblement bisinué en avant, plus fortement en arrière, les côtés parallèles, à peine arqués, sans carène postérieure distincte, la carène latérale oblique et à peine sinueuse, rapprochée de l'inférieure; une vague impression linéaire et arquée longe tout le milieu; la surface couverte de rides sinueuses. Ecusson cuivreux, large, transversalement caréné. Elytres peu convexes, impressionnés à la base, plans sur le disque, déclives sur les côtés, légèrement élargis au tiers postérieur, dentelés et séparément arrondis au sommet, la surface couverte de très fines rugosités regulières et simulant de petites écailles. Dessous plus finement rugueux que le dessus; mentonnière du prosternum forte, échancrée au milieu; pattes médiocres.

LUZON, Los Baños.

Agrilus monticola sp. nov.

Long. 7; larg. 1.8 mm. Moins allongé et plus robuste, plus convexe en dessus que le précédent, le sillon transversal du pro-

notum beaucoup plus large, plus profond et situé plus en arrière vers la base, le sommet des élytres plus largement arrondi, subtronqué et plus fortement dentelé, la région suturale déprimée, entièrement bleu indigo foncé, verdâtre sur les élytres, avec, de chaque côté de ceux-ci, deux monchetures pubescentes et blanches superposées, l'une après le quart postérieur, l'autre à l'apex.

Tête assez forte, un peu plus étroite que la base du pronotum, le vertex convexe et profondément sillonné, la surface ponctuée, moins fortement ridée que chez le précédent; antennes courtes et épaisses. Pronotum plus large que long, un peu plus étroit en avant qu'en arrière, bisinué en avant et en arrière, le lobe médian de l'avant très arqué; les côtés obliques et à peine arqués, la carène postérieure ne rejoignant pas la marginale, celle-ci oblique et sinueuse, l'inférieure parallèle à celle-ci en avant et sinueuse; le disque transversalement impressionné en avant et largement sillonné en arrière du milieu, le sillon remontant sur les côtés au dessus de la carène postérieure; la surface couverte de très fines rayures sinueuses et transversales. Ecusson triangulaire, plus large que haut et caréné transversalement. Elytres déprimés de part et d'autre à la base, sinués sur les côtés, ensuite élargis au tiers postérieur où ils laissent à découvert une étroite portion de la région dorsale des segments abdominaux, atténués obliquement jusqu'au sommet, celui-ci assez largement tronqué et assez fortement dentelé; région suturale très légèrement déclive; suture saillante en arrière; la surface assez rugueuse et couverte de rugosités simulant des écailles. Dessous moins rugueux que le dessus, couvert d'une pubescence très courte, regulièrement espacée sur l'abdomen; mentonnière du prosternum large, subsinueuse et tronquée en avant; pattes peu robustes.

LUZON, Mt. Maquiling.

Agrilus fontanus sp. nov.

Long. 5; larg. 1 mm. Allongé, subparallèle sur les côtés, entièrement noir en dessus, la moitié interne des élytres couverte d'une courte pubescence grisâtre peu visible, le dessous d'un noir plombé, entièrement couvert d'une courte pubescence grise.

Tête forte, aussi large que la base du pronotum, convexe, faiblement sillonnée sur le vertex, couverte de très fines rides transversales et sinueuses. Pronotum presque carré, plus large que long, aussi large en avant qu'en arrière, la marge antérieure plus fortement bisinuée que la postérieure, avec un large lobe médian avancé; les côtés subparallèles, à peine arqués; carène postérieure grande, arquée, rejoignant la marginale en avant

du milieu; carène laterale subsinueuse, visible en dessus, l'inférieure assez éloignée d'elle en avant; le milieu du disque avec une très vague fossette en avant et une autre plus nette, au dessus de l'écusson; la surface couverte de rides sinueuses et transversales bien marquées. Ecusson petit, plus large que long, caréné transversalement. Elytres couvrant entièrement l'abdomen, transversalement deprimés à la base, légèrement le long de la suture, celle-ci élevée et lisse sur presque toute sa longueur, sauf à la base; le sommet séparément arrondi et à peine dentelé; la surface également couverte de rugosités simulant de très fines écailles. Dessous plus clair et un peu plus luisant que le dessus; mentonnière du prosternum grande, largement lobée; pattes assez robustes.

LUZON, Los Baños.

Agrilus balnearis sp. nov.

Long. 4.5; larg. 0.7 mm. Ecourté, assez convexe, atténué en arrière, entièrement bleu brillant, avec, sur les élytres, une large bande bleu d'acier foncé et glabre, tandis que le reste des élytres et du dessous sont couverts d'une très courte pubescence gris blanchâtre, plus dense sur la région postérieure des élytres, après la bande noire.

Tête forte, avec les yeux épais et très saillants en dehors, sillonnée longitudinalement au milieu, et entièrement couverte de rides sinueuses. Pronotum bisinué en avant, aussi large en avant qu'en arrière, sa plus grande largeur au milieu, les côtés arqués; carène postérieure grande, sinueuse et rejoignant la marginale en avant du milieu; carène marginale plus sinueuse que l'inferieure; le milieu du disque à peine déprimé transversalement au dessus de l'écusson; la surface couverte de rides sinueuses et transversales identiques à celles de la tête. Ecusson mat, transversalement caréné. Elytres légèrement élargis au tiers postérieur, impressionnés à la base, tronqués et tridentés de part et d'autre au sommet; la suture finement corborée du tiers posterieur à l'apex; la surface couverte de rugosités simulant de très fines écailles. Dessous plus lisse et plus brillant que le dessus; mentonnière du prosternum assez grande et lobée; pattes peu robustes.

LUZON, Los Baños.

Agrilus atomus sp. nov.

Long. 3.5; larg. 0.7 mm. Subparallèle, un peu plus large en avant qu'en arrière, entièrement bronzé verdâtre, le front vert

et mat, les élytres et le dessous couverts d'une courte pubescence grise, rare.

Tête étroite en avant et large en arrière, le front aplani, le vertex bombé et sillonné. Pronotum un peu plus long que large et un peu plus large en avant qu'en arrière, la marge antérieure bisinuée avec un large lobe médian avancé et arqué; les côtés légèrement courbes et convergents vers la base; celle-ci faiblement bisinuée, carène postérieure sinueuse et allongée, rejoignant la marginale en avant du milieu; celle-ci oblique, presque droite, en entièrement visible en dessus, l'inférieure arquée; le milieu du disque sillonné, le sillon élargi en arrière; la surface couverte de rides sinueuses et transversales. Ecusson petit, caréné. Elytres largement et peu profondément déprimés à la base, couverts de rugosités simulant de petites écailles, séparément arrondis et inégalement dentelés au sommet. Dessous plus foncé et plus luisant que le dessus; mentonnière du prosternum grande et arquée; pattes peu robustes.

LUZON, Los Baños.

Aphanisticus bodongi sp. nov.

Long. 3.5; larg. 0.7 mm. Appartient au groupe des *Aphanisticus* allongés et cylindriques de l'Europe. Entièrement noir, très légèrement bronzé, brillant. Tête forte, finement pointillée, sillonnée profondément sur toute sa longueur. Pronotum un peu plus large que long, à peine plus étroit en arrière, lisse et brillant comme la tête et très finement ponctué; la marge antérieure bisinuée; les côtés faiblement arqués et un peu convergents en arrière; le disque convexe, limité en avant par un sillon longement la marge et en arrière par un autre sillon plus large; une carène postérieure nette, étroite et perpendiculaire à la base, la marge latérale très oblique. Ecusson très petit, triangulaire. Elytres très rugueux, couverts de rides transversales, légèrement déprimés le long de la suture, largement et séparément arrondis au sommet. Dessous beaucoup moins rugueux que les élytres; marge antérieure du prosternum tronquée, sans mentonnière.

LUZON, Los Baños.

Cette espèce se rétrouve dans l'Inde, à Simla.

Endelus bakeri sp. nov.

Du groupe des *E. weyersi* Rits. et *modiglianii* Kerrem. voisin, pour la tête et le prolongement des tubes oculaires, de l'*E. diabolicus* Kerrem., mais différent de celui-ci par les impressions élytrales et par la coloration générale.

Ecourté, pentagonal, entièrement bronzé plus ou moins clair en dessus; dessous presque noir.

Tête large, profondément creusée; yeux très saillants en dehors, émergeant de tubes écourtés; la surface presque lisse et très brillante. Pronotum beaucoup plus large que long, écourté, tronqué en avant avec les angles antérieurs aigus et avancés; les côtés largement arqués en avant et sinués en arrière avec les angles postérieurs obtus; le milieu du disque avec deux larges carènes transversales. Ecusson petit, triangulaire. Elytres écourtés, saillants à l'épaule, sinueux sur les côtés, atténués obliquement en arrière, largement et séparément arrondis au sommet et très finement dentelés; la surface gondolée et inégale, avec de larges impressions latérales et discales, arrondies sauf celles-ci longeant la suture, de chaque côté du sommet et qui sont allongées. Dessous plus lisse et plus luisant que les élytres.

Long. 3.5-4; larg. 1.25-1.5 mm.

LUZON, Los Baños.

Trachys dubia Saund., Trans. Ent. Soc. London (1879), 328.

LUZON, Los Baños.

Trachys cornuta sp. nov.

Long. 3; larg. 1.6 mm. Remarquable par la forme toute particulière des antennes dont le premier article, très developpé, à la forme d'une mandibule arquée en dedans et cintrée en dehors, comme le montre la figure ci contre de l'antenne du côté droit, alors que les autres articles sont presque moniliformes. Le seul spécimen que j'aie sous les yeux est un mâle; il se peut donc qu'il s'agisse d'un caractère sexuel, mais il est si tranché qu'à première vue il semble que l'antenne soit implantée sur une mandibule dirigée vers l'extérieur.

FIG. 1. L'antenne de *Trachys cornuta*.

Triangulaire, acuminé en ligne presque droite en arrière, tête et pronotum bronzé presque noir, les côtés du second garnis d'une pubescence pulvérulente de blanc, les élytres bronzé clair avec une large postmédiane noire, avec, en arrière de cette bande, de chaque côté, une bande pubescente blanche en forme de V; dessous noir.

Tête largement creusée avec le bord interne des yeux tranchant. Pronotum trois fois aussi large que long, échancré en avant et fortement bisinué en arrière, avec les côtés déprimés, largement et obliquement arqués, confluents en avant. Ecusson petit, triangulaire. Elytres graduellement et régulièrement atténués sur les côtés depuis la base jusqu'au sommet, avec, de chaque

côté, une fine côte naissant du calus huméral et longeant la marge latérale à une certaine distance de celle-ci; la surface finement granuleuse, plus lisse sur la bande noire. Dessous luisant, plus lisse que les élytres.

LUZON, Los Baños.

Trachys bakeri sp. nov.

Long. 3; larg. 1.6 mm. Ressemble, pour le facies général, au *T. subbicornis* Motsch., du Japon; entièrement différent de celui-ci pour la coloration et pour le dessin élytral.

Ovoïde, peu convexe, la tête et le pronotum bronzés, la première, plus claire que le second, couverts d'une pubescence couchée, rare et courte; élytres noirs couverts d'une dessin linéaire pubescent de blanc formé par des cercles sur la moitié antérieure et par deux lignes superposées et en zic-zac sur la postérieure. Dessous noir.

Tête brillante, largement et peu profondément creusée en triangle en avant, le bord des yeux non tranchant. Pronotum à bords non aplanis, largement et peu profondément échancré en avant; les côtés obliquement arqués et convergents vers l'avant; la base fortement bisinuée, la surface couverte de points très fins et aciculés. Ecusson réduit à un point à peine visible. Elytres regulièrement atténués en arc despuis l'épaule jusqu'au sommet, celui-ci conjointement arrondi; le calus huméral peu saillant; la base déprimée contre le calus; la surface finement granuleuse; vus de profils, les élytres forment une ligne sinuante légèrement bombée vers le sommet et déclive ensuite. Dessous moins rugueux que le dessus.

LUZON, Los Baños.

Trachys formosana Kerrem., Arch. f. Naturgesch. (1912), 209.

LUZON, Los Baños.

Le type provient de l'île Formose.

ILLUSTRATION

Figure dans le texte

FIG. 1. L'antenne de *Trachys cornuta*.

NOTES ON THE MALAY PANGOLIN, MANIS JAVANICA DESMAREST[1]

By W. SCHULTZE

(From the Entomological Section, Biological Laboratory, Bureau of Science, Manila, P. I.)

Two plates

During a recent trip to Palawan I had the opportunity to observe a specimen of the pangolin, *Manis javanica* Desmarest, in captivity for a period of about three weeks. The animal was captured by a native boy who discovered it in the act of climbing a tree. Previous to the capture of the animal, I had given some attention to the collecting of specimens of termites or white ants. The species that builds the roughly globose nests on the trunks or branches of trees was fairly common about Taytay, and I had observed that many of the nests had been destroyed or partly destroyed. Generally, the disturbed nests had a round or irregularly shaped hole in one side and all or part of the contents of the interior had been removed. Some of the disturbed nests still remained attached to the trunks or branches of trees, while others had been broken off. I was at first inclined to attribute the destruction of the nests to some species of bird, and thought it possible that the bird was feeding on the termites or that it utilized the hollowed nests as breeding places.

Upon receiving the pangolin, I offered it various species of large true ants, but it paid no attention to them and refused to eat. I then secured a fresh brood comb from a terrestrial termite nest with its included termites, and the pangolin quickly consumed all the insects. To supply the animal in this way with sufficient food presented considerable difficulties, and remembering the destroyed and partly destroyed nests of the arboreal termites that I had observed in the forests the idea occurred to me that the pangolin was probably responsible for their destruction and that these particular termites, to a large degree, sup-

[1] Desmarest, Mammalogie (1822), 2, 377; Blandford, Fauna Brit. India, Mammalia (1891) 599, fig. 199; Hollister, *This Journal, Sec. D* (1912), 7, 35.

plied the food of the animal. I accordingly secured several of these arboreal termite nests, and placed them in the cage with the animal. The pangolin commenced to break open a nest shortly after dark. Its method of accomplishing this is very peculiar. First, it is necessary to give some idea of the characters of the nest in order better to understand how well the animal is adapted to its food supply.

The termite nests are usually subglobose, sometimes being rather irregular in shape, and from 20 centimeters to 50 centimeters in diameter. In color they are usually dark brown or black, and externally have a rather flaky appearance. The outermost part of the nest is rather thin, and is brittle in texture. The entire interior of the nest is made up of a somewhat porous material that is more or less sponge-like in appearance, but not at all sponge-like in texture, being very hard and somewhat brittle. In the region where the queen chamber is located, the surrounding material is still harder, and the passages or cells are slightly smaller than in the external portions.

In opening the nest the pangolin at first removes the outer layer from one side by means of its powerful claws. The animal then commences working its way into the interior of the nest by inserting its claws into the passages or cells and using them as levers, thus breaking away, in small pieces, the very hard material that makes up the interior of the nest. While doing this work, the animal may assume any position—standing on its hind legs or lying down on its side, on its belly, or even on its back on the top or on the sides of the nest—depending on the location of the nest. As soon as it has worked a short distance into the interior, it reaches the regions inhabited by the termites, and, while busily engaged with its claws in breaking down the interior of the nest, it keeps its tongue constantly protruded, licking up the termites that are disturbed or dislodged, in its efforts to reach the interior of the nest. In this manner, the pangolin hollows out the nest sometimes to such a degree that only a thin crust or shell about 3 centimeters in thickness is left. If the nest be very large, it is generally more or less broken up; small nests are rarely broken, but retain their original shape after being hollowed out completely (Plate I). The pangolin under observation consumed the contents of as many as four medium-sized nests in one night. Very probably during the dry season, the Palawan pangolin lives mostly on these arboreal termites. In Palawan, the terrestrial termite nests or mounds are mostly found in rather open brush or grass lands and are so hard that the animal could not burrow into them during the dry season.

It probably uses them as food supply during the rainy season. The pangolin seems to have poor eyesight, at least during the daytime. However, its sense of smell is apparently very acute. Its sense of direction is undoubtedly largely dependent on scent. The animal under observation was repeatedly liberated, and soon after being removed from its cage it raised its head and sniffed in various directions. It then invariably turned toward the nearest forest or thicket and walked away in that direction. When it had decided upon a given course, no amount of turning could deflect it, and after being turned about it always resumed its original direction. Even lifting the animal by its tail and quickly revolving it failed to confuse it. It never turned toward open places or toward the sea. There is little doubt that it depends largely upon its sense of smell in locating termite nests, especially those that are placed high in the trees. If disturbed when walking about, it quickly puts its head between its front legs, turns a somersault, and rolls up into a ball (Plate II, fig. 2), making a hissing noise when so doing. Its powerful tail (Plate II, fig. 3), which has a horny pad on the end, is a great aid to the animal in climbing and in hanging on branches of trees. The animal has a very peculiar odor.

ILLUSTRATIONS

PLATE I

(Photographs by Charles Martin)

FIG. 1. Arboreal termite nest hollowed out by *Manis javanica* Desmarest, showing opening.

2. Opposite side of the termite nest shown in fig. 1.

PLATE II

(Photographs by courtesy of Dean C. Worcester)

FIG. 1. *Manis javanica* Desmarest in walking position.

2. *Manis javanica* rolled up.

3. *Manis javanica* climbing.

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Fig. 1. Showing opening.

Fig. 2. Opposide side of the nest shown in fig. 1.

PLATE I. ARBOREAL TERMITE NEST HOLLOWED OUT BY MANIS JAVANICA DESMAREST.

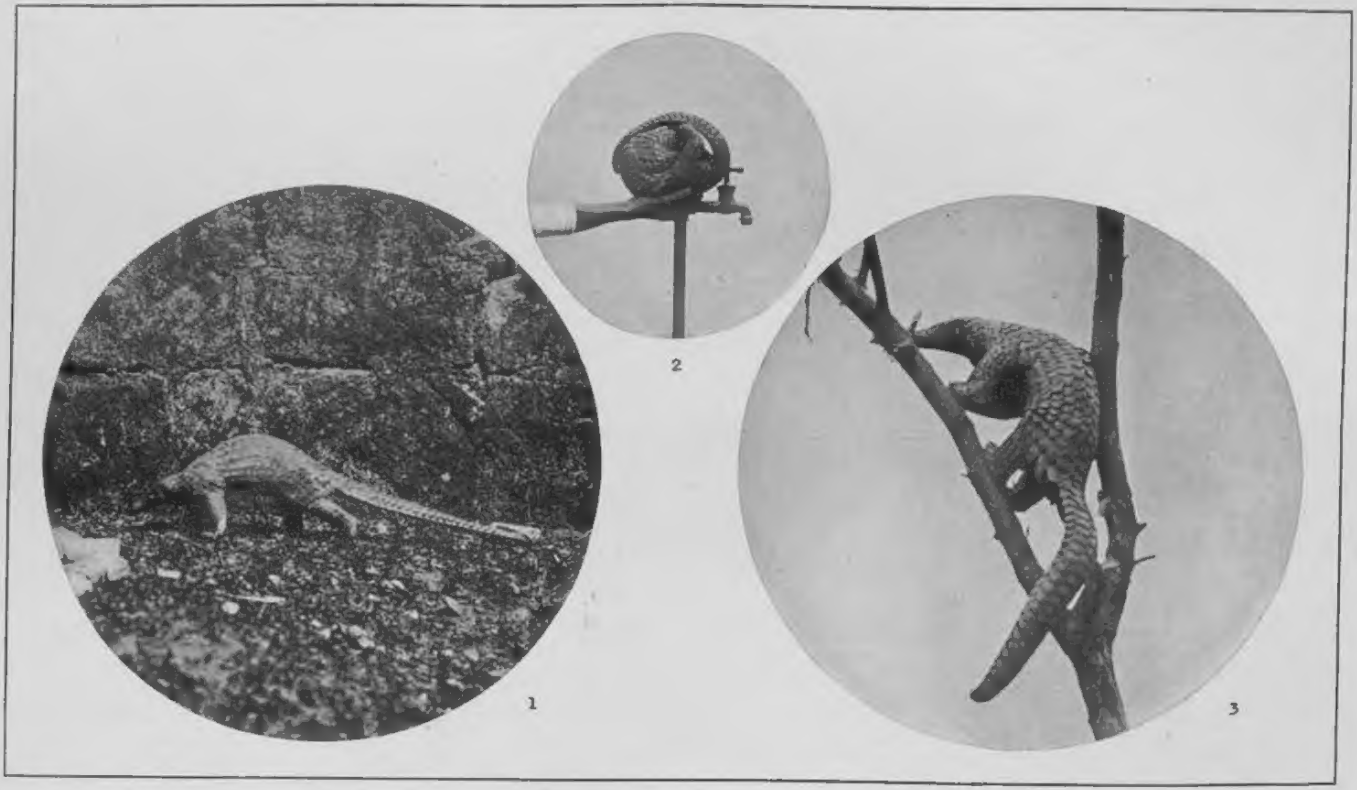

Fig. 1. In walking position. 2. Rolled up. 3. Climbing.

PLATE II. MANIS JAVANICA DESMAREST.

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